THIRTEENTH EDITION

HAND BOOK

OF

THE ELECTRIC POWER CLUB

EXECUTIVE STAFF
MEMBER COMPANIES
COMMITTEES
CONSTITUTION AND BY-LAWS
NOMENCLATURE
STANDARDS
INDEX
ADDENDA

AUGUST, 1920

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PREFACE

The co-operation existing between the Electric Power Club and the American Institute of Electrical Engineers in the field of electrical standardization is indicated by the following resolutions which have been adopted by the two organizations:

1. Resolution adopted by the Board of Directors of the A. I. E. E., April 9, 1913:

> "RESOLVED, that it is the sense of this Board that co-operation between the Standards Committee of the Institute and the Standards Committees of other national societies dealing with units and standards appertaining to or applicable in electrical engineering, or in the allied arts or sciences, is desirable, and it suggests that the Standards Committee shall take no action on any subject matter outside of the field of electrical or magnetic standardization, and within the field of the Standards Committee of another national society, before coming to an agreement with the Standards Committee of that society, provided that a reciprocal courtesy is extended by such Standards Committee of such society."

2. Resolution adopted by the Board of Governors of the Electric Power Club, May 3, 1916:

> "RESOLVED, that it is the sense of this Board that co-operation between the Standardization Committee of the Electric Power Club and the Standards Committee of the A. I. E. E. is desirable, and that the Standardization Committee of the Electric Power Club is hereby instructed to further such co-operation to the fullest extent, and in the field of commercial electrical standardization upon which this Club is engaged, to be guided by the general engineering and technical limitations established in the Standardization Rules of the A. I. E. E.; be it further
>
> "RESOLVED, that a copy of this resolution be forwarded to the Board of Directors of the A. I. E. E. in acknowledgment and acceptance of their resolution of April 9, 1913."

The line of demarkation in the standardization work of the two bodies may be briefly indicated by the following statements:

1. The preface to the Standardization Rules of the A. I. E. E. states the purpose of their work of standardization as follows:

"In framing these rules, the chief purpose has been to define the terms and conditions which characterize the rating and behavior of electrical apparatus, with special reference to the conditions of acceptance tests.

"It has not been the purpose of the rules to standardize the dimensions or details of construction of any apparatus lest the progress of design and production should be hampered."

2. Recognizing the jurisdiction of the A. I. E. E. in the field of electrical engineering and emphasizing especially its proper function in establishing such general limitations and requirements in the rating, test and performance of electrical machinery from an engineering and technical standpoint as will insure satisfactory results, it is the purpose of the Electric Power Club and the scope of the rules contained in this book:

a. To describe, classify, and define commercial types of electrical machinery, their operating characteristics and the terminology of structural details.

b. To establish commercial rating standards, such as standard voltages, load ratings, time ratings, speeds, etc.

c. Within the general engineering limitations the Rules of the A. I. E. E., to establish the kind of rating to be used and the actual performance guarantees under which different types of electrical machinery are manufactured and sold.

d. As far as practicable, to establish standards in manufacturing practice, and in the structural details of electrical machinery.

Recognizing the desirability of co-operation in order to prevent conflict and the putting of more than one standard before the public, The Electric Power Club is willing and anxious to co-operate with other organizations interested in the standardization of electrical apparatus or in the betterment of conditions in the electrical industry.

NOTE—Wherever the rules of the A. I. E. E. are referred to in this book the November 8, 1918 edition of the rules is used.

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1919-1920

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Electric Controller & Mfg. Co.	H. F. Stratton
Electric Machinery Co.	Truman Hibbard
The Electric Products Co.	T. Williams
Electro Magnetic Tool Co.	Geo. L. Newcomb
Electro-Dynamic Co.	J. Farber
Emerson Electric Mfg. Co.	T. M. Meston
Fairbanks, Morse & Co.	L. J. Osborn
General Electric Co.	J. T. Stockdale
Goodman Mfg. Co.	A. B. Benedict
Gould Storage Battery Co.	
Hamilton-Beach Mfg. Co.	A. J Druse
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The Holtzer-Cabot Elec. Co.	E. R. Harding (Chicago) W. E. Haseltine (Boston)

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Independent Pneumatic Tool Co.	F. W. Buchanan
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1919-1920

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The Electric Products Co.
Emerson Electric Mfg. Co.
Fairbanks Morse & Co.
General Electric Co.
Hamilton Beach Mfg. Co.
Holtzer Cabot Electric Co.
Howell Electric Motors Co.
Ideal Elec. & Mfg. Co.
Imperial Electric Co.
Kimble Electric Co.
Lincoln Electric Co.
Mechanical Appliance Co.
Marble Card Electric Co.
Northwestern Mfg. Co.
Otis Elevator Co.
Peerless Electric Co.
Phoenix Electric Co.
Reliance Electric & Engineering Co.
Reynolds Electric Co.
Ridgway Dynamo & Engine Co.
Robbins & Myers Co.
Rochester Electric Products Corp.
Roth Bros. & Co.
B. F. Sturtevant Co.
Triumph Electric Co.
U. S. Electrical Mfg. Co.
Wagner Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

7000—Portable Electric Tool Section

Members

W. J. Friedlander, *Chairman*
Care Hisey Wolf Machine Co.,
Colerain and Marshall Ave., Cincinnati, O.

Black & Decker Mfg. Co.
Burke Electric Co.
Chicago Pneumatic Tool Co.
Cincinnati Electrical Tool Co.
Jas. Clark, Jr., Elect. Co.
Electro-Magnetic Tool Co.
The Hisey Wolf Machine Co.
Independent Pneumatic Tool Co.
Neil & Smith Electric Tool Co.
Reynolds Electric Co.
Temco Electric Motor Co.
U. S. Electrical Tool Co.
Van Dorn Electric Tool Co.

7800—Mining and Industrial Locomotive Section

Members

S. B. Belden, *Chairman*
Care Jeffrey Mfg. Co., First Ave., Columbus, O.

Goodman Mfg. Co.
General Electric Co.
Ironton Engine Co.
Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

8000—Industrial Control Section

Members

H. D. James, *Chairman*
Care Westinghouse Elect. & Mfg. Co.,
E. Pittsburgh, Pa.

Allen Bradley Co.
Automatic Switch Co.
Condit Electrical Mfg. Co.
Crocker Wheeler Co.
Cutler Hammer Mfg. Co.
Electric Controller & Mfg. Co.
General Electric Co.
Industrial Controller Co.
Monitor Controller Co.
Union Electric Mfg. Co.
Wagner Electric Mfg. Co.
Ward Leonard Electric Co.
Westinghouse Electric & Mfg. Co.

9000—Transformer Section

Members

M. O. Troy, *Chairman*
Care General Electric Co., Pittsfield, Mass.

Allis Chalmers Mfg. Co.
American Transformer Co.
Burke Electric Co.
Duncan Electric Mfg. Co.
General Electric Co.
Kuhlman Electric Co.
Maloney Electric Co.
Packard Electric Co.
Pittsburgh Transformer Co.
Wagner Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

10,000—Power Switchboard & Oil Circuit Breaker Section

Members

J. W. Upp, *Chairman*
Care General Electric Co., Schenectady, N. Y.

Allis Chalmers Mfg. Co.
Condit Electric Mfg. Co.
General Electric Co.
Railway & Industrial Engineering Co.
Westinghouse Electric & Mfg. Co.

12,000—Electric Measuring Instrument Section

Members

Chairman

General Electric Co.
Moloney Electric Co.
The Packard Electric Co.
Pittsburgh Transformer Co.
Sangamo Electric Co.
Wagner Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

SUB-COMMITTEES

General Engineering Recommendations Committee. *(b)*

Prof. Benj. F. Bailey, *Chairman*

One member from each Section.

H. C. Petty (M. & G.)
S. B. Belden (M. & I. L.)
(P. E. T.)
(E. M. I.)
T. J. Pace (P. Swb.)
W. P. White (T.)
W. C. Yates (I. C.)
(S. B.)

Nomenclature Committee. *(b)*

F. M. Kimball, *Chairman*
W. E. Haseltine

Underwriters Committee. *(b)*

J. M. Curtin, *Chairman*

A. H. Moore
T. E. Barnum
R. J. Russell

References:

(a) These committees report to the Board of Governors.
(b) These committees report to the Standardization Committee.
(c) Created temporarily to do special work.

SPECIAL COMMITTEES
1919-1920

Tariff Committee (*a*) (*c*)

S. L. Nicholson, *Chairman*

Theo. Beran — Warren A. Myers
A. L. Doremus — R. J. Russell
C. E. Searle

Foreign Trade Committee (*a*)

C. L. Collens, *Chairman*

W. D. Baldwin — E. R. Ellis
A. L. Doremus — J. F. Lincoln
R. J. Russell

Delegate to Power Sales Bureau of Commercial Section of N. E. L. A. (*a*)

A. L. Doremus

Cost Accounting Committee. (*a*)

H. F. Stratton, *Chairman*

F. E. Craig — H. F. Vogt
W. S. Kemp — W. S. Thomas

Manufacturers' Council Delegates. (*a*) (*c*)

Jas. C. Hobart, *Chairman*
(Term expires 1924)

C. L. Collens, 2d — E. R. Harding
(Term expires 1923) — (Term expires 1922)
H. C. Petty
(Term expires 1921)

The Electric Safety Conference Delegates (*a*)

President of Club (Jas. Burke)
Alternate, A. L. Doremus
Chairman, Safety Standardization Committee
(A. H. Moore)
Alternate, H. C. Petty

ORGANIZATION AND METHOD OF OPERATION

1. Board of Governors.

The Board of Governors is elected by the club as prescribed in the Constitution and acts as a reference body, co-ordinating, suggesting, limiting and guiding the policies of the several standing and special committees, of the section chairmen and of the working sections.

2. Standing Committees.

Standing committees are appointed by the president, subject to the approval of the Board of Governors. Their duties call for initiative rather than participation in the minutae of development. They should co-ordinate, suggest, outline, and distribute the work to the section committees working under them, in their respective provinces. They report to the Board of Governors, and receive their general instructions from them. They receive all communications and suggestions of work to be performed, which fall within their respective provinces, and assign the work to the respective section committees for development and consummation. All reports of standing committees are subject to approval by the Board of Governors before submission to a meeting of the club.

3. Section Committees.

Section committees are appointed by each section chairman, subject to the approval of the Board of Governors, to develop and formulate such detailed rules, standards, recommendations or policies relating to the products or business of the manufacturers constituting the group as falls within their respective provinces. In each phase of their work they report to the proper standing committee having general supervision of that particular class of activity. Section committees receive the subjects to be investigated from the section chairman or from the standing committees under which they work. The section committees, however, should recognize the need of initiative and should originate work in their

espective departments, which is thought to be essen-
ial or desirable. All rules, standards, practices or
olicies recommended by a section committee shall
e developed within the membership of the working
ection and presented to the club for action in
ccordance with the rules of procedure specified
nder Method of Work.

4. Section Chairmen.

A section chairman is elected by each working
ection as prescribed in the Constitution. He calls
nd presides at all meetings of his section, receives
ommunications from the members of his section
or action by the section committees or Board of
Governors, co-ordinates the work of all section
ommittees representing his section, and in general
romotes the interests of the manufacturers whom
e represents in their activities and relationships
oth within and without the club. He should de-
elop cordial relations with all manufacturers of the
articular class or classes of product embraced
vithin his group, whether they are members of the
lub or otherwise, and should see that the interests
f non-members are properly taken into account in
ll group activities. He shall furnish a list of non-
nember companies to the Board of Governors and
hall co-operate with the Membership Committee in
ecuring members.

5. Working Sections.

The membership of the club is divided into work-
ng sections, each section embracing all member
ompanies who manufacture a particular class or
lasses of product. Under the direction of the Sec-
ion Committees, detailed rules, standards, practices,
tc., are developed within each working section.
This may be done either by questionnaire, letter
anvass, or by meetings of the working section.
These meetings, as specified by the section chairman,
nay be either executive or general. Working Sec-
ions in all their activities are guided by policies
rescribed by the Board of Governors.

6. Special Committees.

These committees investigate the special subject or work referred to them, and report thereon to the Standing Committee, officer, or Board of Governors, as the case may be, designated by the resolution creating such special committee.

7. Method of Work.

1. Subjects initiated by or referred to a section committee shall be thoroughly analyzed, studied and investigated by the section committee before final findings are submitted to the working section for approval.

2. Information desired by the Section Committee from the members of the section shall be obtained preferably by means of a questionnaire, which shall contain a brief statement of the subject under investigation, and a definite series of questions indicating clearly the information or data desired, and shall request full discussion.

3. The final findings of the Section Committee shall be in the form of a definite recommendation for insertion in the Hand Book, followed by a brief discussion indicating the arguments advanced both for and against the recommendations made, and shall be submitted in written or printed form to the working section for approval at least four weeks prior to the meeting of the club at which formal action will be requested. The committee shall in all cases indicate whether the recommendation is submitted as an Adopted Standard, Recommended Practice, or Suggested Standard for Future Design. No recommendation shall be filed by a section committee which has not received a two-thirds favorable vote of the entire membership of the working section or an unanimous vote of all members present at a meeting of the section, a majority of the entire section membership being in attendance.

4. It is recommended that the questionnaires be sent to non-members manufacturing the class of product to which the recommendation relates, and that non-members be given full opportunity to criticise and make recommendations.

5. Where the work can be facilitated thereby, called meetings of the working section may take the place of a canvass by questionnaire or letter, but in all cases the final findings must be submitted to all members of the section, including those not present at the called meeting, at least four weeks prior to the meeting of the club at which final action will be requested.

6. The final report of the Section Committee shall embody the final findings, and discussion as submitted to the working section for approval, supplemented by a list giving the names of the representatives and company affiliations of all who were given an opportunity to participate in the work of formulation, as well as of all who concurred in the final recommendation. The final report, in written or printed form, shall be filed with the proper standing committees for approval at least two weeks prior to the meeting of the club at which final action will be taken. At the time of so filing the section committees shall notify all companies opposing the recommendation of its decision, requesting each such company to immediately file a detailed statement of its objections with the Standing Committee. The statements so filed shall be attached as a minority report to the report of the Section Committee.

7. Any final report accompanied by a minority report shall be referred by the Standing Committee of the Board of Governors before it is brought before a general meeting of the club, and it shall be the duty of the Board of Governors to determine whether any injustice is done the minority in the recommendations, and to make a report of its findings to the club.

8. If approved by the proper standing committee, final reports shall be submitted to the Club for adoption.

9. In general, it is recommended that standing committees or special committees pursue the same general procedure indicated above for section committees in consummating their reports.

RULES OF PROCEDURE

In Relation to Standardization by the Electric Power Club

1. Adopted Standards.

a. Any rule, definition, practice, basis of test, rating standard, or performance specification adopted by The Electric Power Club as a definite standard or as a definite limit shall be known as an "Adopted Standard." Three classes of Adopted Standards shall be recognized, namely: (1) Definite Fixed Standards; (2) Minimum Limits; (3) Maximum Limits.

An adopted standard of The Electric Power Club defines a practice or construction to the observance of which, in the interest of the public, all members of the Club should adhere, and in no event should a member of the Club represent as standard apparatus any material falling below such standard.

b. Adopted Standards shall be adopted only upon unanimous vote of the members present at a general meeting, following four weeks notice. The notice shall give the rule in full and shall state specifically that it is being recommended as an Adopted Standard.

c. Identification and References in the Handbook to date of adoption and date of revision shall be placed below rule in small type in the following form:

(1)—Adopted Standard.
May 3rd, 1916.

This clause shall follow all rules which are fixed standards and to be followed without variation.

(2)—Adopted Standard.
(Minimum limit)
May 3rd, 1916.

This clause shall follow all rules which are adopted as minimum limits, and if departure is made therefrom it shall be in the direction of larger values only.

(3)—Adopted Standard.
(Maximum limit)
May 3rd, 1916.

This clause shall follow all rules adopted as maximum limits, and if departure is made therefrom, it shall be in the direction of smaller values only.

d. An adopted standard may only be rescinded, following three months notice of the action proposed, by a two-thirds vote of the entire membership, or upon unanimous vote of the members present at a general meeting.

e. Apparatus complying with the adopted standards of The Electric Power Club may bear an authorized distinguishing mark to that effect.

f. It is distinctly understood that the Adopted Standards relate only to products commercially standardized and subject to repetitive and quantity manufacture, and do not apply to products built to meet the special requirements of individual customers.

2. Recommended Practice.

a. Any suggestion or practice with reference to which it may be impracticable to secure full acceptance from each member of The Electric Power Club, but with reference to which it is desirable to recommend uniform practice, shall be approved and known as "Recommended Practice." Three classes of Recommended Practice shall be recognized, namely: (1) Fixed Values, (2) Minimum Limits, (3) Maximum Limits.

A Recommended Practice of The Electric Power Club defines a practice or construction which in the interest of uniformity of procedure is favored by a majority of the members of the Club.

b. Recommended Practice shall be adopted only upon two-thirds vote of the members present at a general meeting, following thirty days advance notice. Notice shall give the rule in full and shall state specifically that the rule is being submitted as Recommended Practice.

c. Identification and references in the Handbook to date of approval and date of revision shall be placed below the rule in small type in the following form:

(1)—Recommended Practice.
May 3rd, 1916.

This clause shall follow all rules adopted as fixed values of Recommended Practice, to be followed without variation.

(2)—Recommended Practice.
(Minimum limit)
May 3rd, 1916.

This clause shall follow all rules adopted as minimum limits of Recommended Practice, and if departure is made therefrom it shall be in the direction of larger values only.

(3)—Recommended Practice.
(Maximum limit)
May 3rd, 1916.

This clause shall follow all rules adopted as maximum limits of Recommended Practice, and if departure is made therefrom it shall be in the direction of smaller values only.

d. Suggestions of Recommended Practice may only be rescinded by the same action and vote as are required for rescinding an Adopted Standard.

3. Suggested Standards for Future Design.

a. Any rule or standard which cannot be approved either as an adopted standard or as recommended practice, but is merely recommended for future designs, shall be adopted and known as a "Suggested Standard for Future Design." Three classes of Suggested Standards for Future Design shall be recognized, namely: (1) Fixed Values, (2) Minimum Limits, (3) Maximum Limits.

b. The same notice and vote are required for Suggested Standards for Future Design as specified for Recommended Practice.

c. Suggested Standards for Future Design shall be printed on buff colored paper for the loose leaf Handbook. Identification and reference to date of approval and date of revision shall be placed below the rule in small type in the following form:

(1)—Suggested Standard for Future Design.
May 3rd, 1916.

This clause shall follow all rules adopted as fixed values of suggested Standards for Future Design to be followed without variation.

(2)—Suggested Standard for Future Design.
(Minimum limit)
May 3rd, 1916.

This clause shall follow all rules adopted as minimum limits of Suggested Standards for Future Design, and if departure is made therefrom it shall be in the direction of larger values only.

(3)—Suggested Standard for Future Design.

(Maximum limit)

May 3rd, 1916.

This clause shall follow all rules adopted as maximum limits of Suggested Standards for Future Design, and if departure is made therefrom it shall be in the direction of smaller values only.

d. Suggested Standards for Future Design may only be rescinded by the same action and vote as are required for rescinding an Adopted Standard.

4. Departures from Adopted Standards.

a. It is recognized by the members of The Electric Power Club:

(1) That the advance of the industry, the progressive development of the art of manufacturing electrical apparatus, or the rewards to which individual members are properly entitled as the result of initiative, research and invention, must not be retarded or curtailed by adopted standards to which the majority still subscribe; (2) that during a period of change or progressive development honest differences of opinion may arise over a proposed change or departure from an existing standard; and (3) that where there is reasonable evidence that such change is in the public interest, it is desirable that, while its merits are being generally demonstrated, the departure be formally recognized by The Electric Power Club as the authoritative body controlling the standardization of electrical apparatus.

b. Application for recognition in respect to a departure from the adopted standards of The Electric Power Club shall be made in writing and shall be filed with the Secretary thirty days in advance of general commercial introduction.

c. Upon favorable recommendation of the Board of Governors, approved by a two-thirds vote of the entire membership, or by an unanimous vote of all members present at a general meeting, a departure may be formally recognized.

CONSTITUTION

of

THE ELECTRIC POWER CLUB.

ARTICLE I.

Name

The name of this organization shall be The Electric Power Club.

ARTICLE II.

Objects

The objects of this organization are:

a. The discussion of subjects of interest and value to the industry in which its members are engaged.

b. The advancement and improvement of that industry.

c. The collection and dissemination of statistics and information of value to its members.

d. The standardization of electrical machinery.

e. The promotion of a spirit of co-operation among its members for the improved production and increased distribution of electrical machinery and apparatus.

ARTICLE III.

Membership

a. Membership in this club shall be limited to corporations, firms or individuals actively engaged in the manufacture of Electrical Power Apparatus and Control Equipment. Each such membership shall be known as a *member company.*

EXPLANATORY NOTE.—A prospective or accepted member of The Electric Power Club shall be considered as "actively engaged" in any given line of manufacture, within the scope of the activities covered by The Electric Power Club, constitutes a principal or important part of his output regularly and constantly produced and sold.

b. The membership of the club shall be divided into working sections, each section embracing all member companies who manufacture a specified class or closely allied classes of electrical power apparatus or control equipment. All rules and recommendations relating to the class or classes of product constituting a section shall be formulated within the working section and shall be presented to the club for adoption in

the manner prescribed from time to time by the Board of Governors, the procedure prescribed being subject to formal approval by the club. A working section may be specified or added at any time upon recommendation by a majority vote of the Board of Governors and upon approval by a majority of the entire membership of the club following one month advance notification that such action is proposed.

c. Each member company shall be entitled to one vote.

d. Each member company shall select from its organization one or more representatives whom it shall designate as its executive representative or representatives; it may select one or more whom it shall designate as associate representatives; and should the Board of Governors arrange any further classification, such member company may designate representatives for that class.

e. An executive representative shall be an executive officer of the member company or some one in its employ authorized to act for such member company.

f. An associate representative shall be an employee of a member company.

g. The Board of Governors at its discretion shall have the power to establish an additional class or classes of representatives.

h. The classification of representatives by a member company shall be subject to the approval of the Board of Governors, and it may place a limit on the number of representatives which a member company may designate for any class.

i. Representatives unavoidably absent from any meeting may be represented by proxy, said proxy to be subject to the approval of the Board of Governors.

j. Applications for membership must be made to the Board of Governors in writing on forms approved by the Board of Governors, and such forms, to be signed by the applicant, shall contain an acceptance of the Constitution and By-Laws of the Club and an obligation to abide by the same. Each applicant for membership shall secure on said application the signature of not less than two members of The Electric Power Club as sponsors. If the application is approved by the Board of Governors, it shall be submitted to the membership at the next meeting for election. Voting on applications shall be done on a written ballot. Each member company shall be entitled to one vote, and the Executive representative voting shall sign the name of his company on the ballot. A majority of the members present shall be necessary for an election.

ARTICLE IV.

a. The annual meeting and election shall be held during the months of May or June, the time and place of such meeting to be selected by the Board of Governors.

b. The management of this club shall be entrusted to a Board of Governors, composed of twelve executive representatives, no two representing the same member company, and four are to be elected each year. They shall hold office for a term of three years, except as provided by Section *c.*

c. Of the members of the Board of Governors elected at the meeting at which this amendment is adopted, or at any subsequent special election, the four receiving the highest number of votes shall serve three years, the four receiving the next highest number of votes shall serve two years, and the four receiving the next highest number of votes shall serve one year. In the event of a tie, lots shall be drawn to decide whether a candidate shall serve the three, two or one year term.

d. The officers of this club shall be a President, Vice-President, Treasurer and Secretary, who shall be elected by the Board of Governors from among their own number. The Method of Election shall be by written ballot. They shall hold their office for one year, or until their successors shall have been elected, and shall perform such duties as usually pertain to their office.

e. Seven members of the Board of Governors shall constitute a quorum.

f. In the case of a vacancy in the Board of Governors, the Board shall have the power to fill same, such member to serve until the next annual election, when such vacancy shall be filled regularly by the vote of the membership.

g. At the annual meeting of the club each working section shall by formal ballot elect a Section Chairman who is a representative of a member company entitled to membership in the section, and who shall hold office for one year, or until his successor is chosen. Each Section Chairman shall act in an advisory capacity to the Board of Governors . The Section Chairman shall preside at all group meetings, shall co-ordinate the work of all subcommittees representing his group, and in general shall promote the interest of the manufacturers whom he represents in their activities and relationships both within and without the club. The functions of Section Chairmen and the activities of all working sections shall be subject to such limitations and to such regulations as are prescribed by the Board of Governors and as are formally approved by the Club.

ARTICLE V.

Amendments

Amendments to this Constitution must be submitted in writing to the Board of Governors, and by them, with their recommendation, to the club at its next regular meeting; in order to be acted on at that time, twenty days' written notice must have been given by the secretary to each membership, stating the proposed amendment and the recommendation of the Board of Governors. In the absence of such notice, action must be deferred until the next meeting of the club. A two-thirds vote of the entire membership shall be necessary for the adoption of any amendment.

BY-LAWS

of

THE ELECTRIC POWER CLUB

ARTICLE I.

Order of Business

1. Reading of the minutes.
2. Reports of standing committees.
3. Reports of special committees.
4. Election and resignation of members.
5. Unfinished business.
6. Communications.
7. New business.

ARTICLE II.

President

The President, or in his absence, the Vice-President, shall preside at all meetings of the club or Board of Governors. He shall appoint such standing or special committees as desired or directed, subject to the approval of the Board of Governors.

ARTICLE III.

Vice-President

The Vice-President shall perform the duties and exercise the functions of the President in the event of his absence or disability, and in the absence or disability of the Vice-President a temporary chairman may be elected by a majority vote of those present to preside at any meeting.

ARTICLE IV.

Secretary

The Secretary shall have charge of the books and papers belonging to the club, and shall keep a record of the proceedings of the club, and of the Board of Governors. He shall make and forward notifications of all meetings to each member, shall issue orders on the treasurer for payment of all bills authorized by the Board of Governors; he also shall notify new members of their election.

ARTICLE V.

Treasurer

The treasurer shall have charge of all funds of the club, collect dues, and pay bills authorized by the Board of Governors on approval of the secretary. He shall make a report on the condition of the funds at each annual meeting of the club, or as often as the Board of Governors or the club may demand.

The treasurer shall keep all funds of the club in some bank approved by the Board of Governors, and in the name of The Electric Power Club; all funds shall be subject to check of the treasurer in payment of vouchers duly approved by the secretary. He shall give such bond as may be required by the Board of Governors for the faithful performance of his duties, the premium on said bond to be paid by the club.

ARTICLE VI.

Board of Governors

The Board of Governors shall have entire control of the internal affairs of the club. It shall pass upon all applications and resignations before presentation to the club. It shall designate the place of the regular meeting unless otherwise directed by the vote of the club.

Special meetings may be called by its order, and the time and place of regular meetings fixed or changed by its direction.

ARTICLE VII.

Meetings

Meetings of the club may be either executive or general. At executive meetings only executive representatives shall be present. At general meetings only executive representatives shall vote, but all classes of representatives shall have the privilege of the floor.

ARTICLE VIII.

Dues

Each member company shall pay the sum of $50 per year for each executive representative and $15 per year for each associate representative. Should other classes be established such dues shall be payable by such classes as the Board of Governors may decide.

Annual dues shall be payable within thirty days from date of call, and if not paid within sixty days from call, non-payment shall operate automatically to cancel the membership of the delinquent, but notice of delinquency accompanied by a copy of this Section of the By-laws shall be mailed by the Secretary not less than fifteen days before cancellation of membership becomes effective.

ARTICLE IX.

Nominating Committee

A nominating committee of five executive representatives, not members of the Board of Governors and no two representing the same member company, shall be appointed by the president at least three months prior to each annual meeting. It shall be the duty of this nominating committee, at least thirty days prior to the annual meeting, to mail each executive representative a ticket bearing the names of twice as many executive representatives who have consented to serve as there are vacancies to fill. Any executive representative may make further nominations from the floor.

ARTICLE X.

Amendments

These By-Laws may be altered or amended by a majority vote of the entire membership, at any regular or called meeting, at least ten days' previous written notice having been given the membership by the secretary; or, at the discretion of the Board of Governors, a letter ballot may be taken on any proposed amendment, in which case a majority of the entire membership shall be necessary.

Roberts' Rules of Order shall be the recognized authority of parliamentary procedure.

INTRODUCTION

The following pages cover substantially all the standardization thus far accomplished by the Electric Power Club and its predecessor, the American Association of Electric Motor Manufacturers. Here is represented a great deal of patient work by a series of committees in gathering up, rearranging and agreeing upon what is best of the standard practices of the various manufacturers of motors and generators. Most of these provisions have been formally adopted by the Club with practical unanimity.

This work, it is true, covers but a very small portion of the field of standardization and as time goes on new practices may replace those prescribed herein. Yet we are offering this little volume in the hope of encouraging further standardization and in full belief that these practices contain much that is fundamentally correct and which will be of material assistance in guiding the development of electrical apparatus.

NOMENCLATURE

Reference Number

GENERAL

1. Types as Distinguished by Features of Design

(1001) *Acid Resisting.*
Apparatus so constructed that it will not be readily injured by acid fumes.
(Adopted Standard 11-18-1916.)

(1002) *Drip Proof.*
Apparatus so protected as to exclude falling moisture or dirt. Drip proof apparatus may be either open or semi-enclosed, if it is provided with suitable protection integral with the apparatus, or so enclosed as to exclude effectively falling solid or liquid material.
(Adopted Standard 11-18-1916.)

(1003) *Dust Proof.*
Apparatus so constructed or protected that the accumulation of dust will not interfere with its successful operation.
(Adopted Standard 11-18-1916.)

(1004) *Dust Tight.*
Apparatus so constructed that dust will not enter the enclosing case.
(Adopted Standard 11-18-1916.)

(1005) *Explosion Proof.*

(1006) *Gas Tight.*
Apparatus so enclosed as to exclude the surrounding atmosphere. (Adopted Standard 11-18-1916.)

(1007) *Moisture-Resisting.*
Apparatus in which all parts are treated with moisture-resisting material. Such apparatus shall be capable of operating continuously or intermittently in a very humid atmosphere, such as that of mines, evaporating rooms, etc.
(Adopted Standard 11-18-1916.)

(1008) *Splash Proof.*
Apparatus protected against the entrance of a spray of water from any direction.
(Adopted Standard 11-18-1916.)

(1009) *Submersible Apparatus.*
Apparatus so constructed as to be capable of withstanding complete submersion in water for four hours without injury.
(Adopted Standard 11-18-1916.)

Reference Number

(1010) *Weather Proof.*

Apparatus so constructed or protected that it will not be injured if exposed to the weather.

(Adopted Standard 11-18-1916.)

2. Service Classifications

(1050) *Continuous Duty.*

A requirement of operation or service which demands the full rated output of the apparatus continuously.

(Adopted Standard Revised 11-18-1915.)

(1051) *Intermittent Duty.*

A requirement of operation or service consisting of alternate periods of load and rest so apportioned and regulated that the temperature rise at no time exceeds that specified for the particular class of apparatus under consideration.

(Adopted Standard Revised 11-18-15.)

(1052) *Periodic Duty.*

A requirement of operation or service demanding alternate periods of load and rest, in which the load conditions are well defined and recurrent as to magnitude, duration and character, so apportioned that the temperature rise at no time exceeds that specified for the particular class of apparatus under consideration. (Adopted Standard Revised 11-10-1915.)

(1053) *Varying Duty.*

A requirement of operation or service in which the apparatus is called upon to run at loads, and for periods of time, which may be subject to wide variation, but which are in no case sufficient to cause the maximum temperature rating to be exceeded. In no case shall the no load losses be sufficient to cause the maximum temperature rating to be exceeded in any part under no load continuous operation.

(Adopted Standard 5-20-1912.)

3. Terms of Rating, Performance and Test

(1060) *Ambient Temperature.*

The Ambient Temperature is the temperature of the air or water which, coming into contact with the heated parts of a machine, carries off its heat. (A. I. E. E. 303.)

Commonly known as "Room Temperature" in connection with air cooled apparatus not provided with artificial ventilation.

(Adopted Standard 5-1-1916.)

Reference Number

(1061) *Time Rating.*

The period of test run within which the specified conditions of load and temperature rise shall not be exceeded.

(Adopted Standard Revised 11-10-1915.)

MOTORS AND GENERATORS

1. General Classifications

(1110) *Fractional Horse Power Motor.*

A motor built on a frame smaller than that having a continuous rating of 1 H. P., open type, at 1700-1750 R. P. M.

(Adopted Standard Revised 11-10-1915.)

(1111) *Large Power Motor.*

A motor built on a frame having a continuous rating of 1 H. P., open type, at 1700-1750 R. P. M., or larger.

(Adopted Standard Revised 5-13-1915.)

2. Types as Distinguished by Features of Design

(1120) *Commutating Pole Motor with Stabilizing Winding.*

A shunt wound commutating pole motor with a light series winding on the main poles to give stability in speed

(Adopted Standard Revised 11-10-1915.)

(1121) *Enclosed Machine.*

A machine which is so completely enclosed by integral or auxiliary covers as to practically prevent the circulation of air through its interior. Such a machine is not necessarily air-tight.

(Adopted Standard 11-9-1914.)

(1122) *Open Machine.*

A machine of either the pedestal bearing or end bracket type, with no restriction to ventilation other than that imposed by its mechanical construction.

(Adopted Standard Revised 11-9-1914.)

(1123) *Semi-Enclosed Machine.*

A machine in which the ventilating openings in the frame are protected with wire screen, expanded metal or perforated covers, the apertures in which do not exceed ½ of a sq. in. (3.2 sq. cm.) in area.

(Adopted Standard 11-9-1914.)

Reference Number

(1124) *Universal Motor.*

A series wound or a compensated series wound motor that may be operated either upon direct current or alternating single phase current at approximately the same speed and output. These conditions must be met when the alternating current and direct current voltages are approximately the same, and the alternating current frequency is not greater than 60 cycles per second.

(Adopted Standard 11-18-1916.)

3. Speed Classifications

(1170) *Normal Speed.*

(1171) *Adjustable Speed Motor.*

A shunt wound motor in which the speed can be varied gradually over a considerable range, but when once adjusted, remains practically unaffected by variation in load; for example, a motor designed for a considerable range of speed by variation in field strength. (Adopted Standard 10-20-1911.)

(1172) *Adjustable Varying Speed Motor.*

A motor in which the speed can be varied gradually over a considerable range, but in which the speed when once adjusted to a given load will vary in considerable degree with change in the load.

(Adopted Standard 11-9-1914.)

(1173) *Constant Speed Motor.*

A motor in which the speed is practically constant; for example, a synchronous motor; an induction motor with small slip; or an ordinary direct current, shunt wound, constant voltage motor.

(Adopted Standard 11-9-1914.)

(1174) *Multispeed Motor.*

A motor which can be operated at any one of several definite speeds, each being practically independent of the load; for example, a direct current motor with two armature windings, or an induction motor with primary winding capable of various pole groupings. (Adopted Standard 10-20-1911.)

(1175) *Varying Speed Motor.*

A motor in which the speed varies with the load, ordinarily decreasing as the load increases; for example, a series motor, compound motor, or series shunt motor. (Adopted Standard 11-9-1914.)

Reference Number

4. Service Classifications

See Nos. 1050 to 1053, inclusive.

5. Terms of Rating, Performance and Test

(1190) *Rated Load.*

Rated Load shall mean horsepower output for motors, kilowatt output for direct current generators, and kilo-volt-ampere output for alternating current generators.

(Adopted Standard Revised 11-18-1916.)

The A. I. E. E. recommendation to give motor ratings in kilowatts is not followed, all motor ratings being given in horsepower only.

6. Complete Machines and Parts

(1240) *Front.*

In a normal motor or generator, the end opposite that at which the mechanical power is transmitted or received; usually the end of the machine at which the commutator or collector rings are found.

(Adopted Standard 10-30-1911.)

(1241) *Back.*

In a normal motor or generator, the end at which the mechanical power is transmitted or received; usually the end opposite to the commutator or collector rings. (Adopted Standard 10-30-1911.)

(1242) *Complete Generator for Alternating Current.*

(1) Belt type—consists of generator, main driving pulley, exciter driving pulley if required, sliding base or rails, and back of board field rheostat.

(Adopted Standard 5-20-1912.)

(2) Engine type—consists of generator without base, shaft or bearings, without shaft keys or foundation bolts, but with back of board field rheostat, brush rigging support and cap plates when required.

(Adopted Standard 5-20-1912.)

(3) Water wheel type—consists of generator self-contained with bearings and shaft, without sliding base or rails, without pulley or coupling, but with back of board field rheostat and exciter driving pulley when required. (Adopted Standard 5-20-1912.)

Reference Number

(1243) *Complete Generator for Direct Current.*

(1) Belt type—consists of generator, sliding base or rails, and field rheostat. The field rheostats for generators above 10 kw. capacity are of the back of board type, and for generators of 10 kw. and smaller, rheostats are of the front of board type.

(Adopted Standard 5-20-1912.)

(2) Engine type—consists of generator without base, shaft or bearings, without shaft keys or foundation bolts, but with back of board field rheostat and cap-plates when required.

(Adopted Standard 5-20-1912.)

(1244) *Complete Motor, as applied to Fractional Horse Power Motors.*

A motor without sliding base or starter, but with a pulley having a single groove or one flat face.

(Adopted Standard 10-30-1911.

(1245) *Complete Motor, as applied to Large Power Motors.*

An open motor ready to run, including standard pulley, belt-tightening base or slide rails, and hand-operated, no voltage release starter for front of board mounting.

(Adopted Standard Revised 5-20-1912.)

(1246) *Bare Motor.*

An open type motor ready to run, without pulley, belt-tightening base, slide rails or starter.

(Adopted Standard 10-30-1911.)

(1247) *Assembled Field Frame.*

A field frame with necessary complement of poles, pole shoes and field coils assembled thereon.

(Adopted Standard 10-30-1911.)

(1248) *Field Frame.*

The principal magnetic structure in a generator or motor including the poles when an integral part thereof, or to which they may be attached when constructed as separate pieces.

(Adopted Standard 10-30-1911.)

(1249) *Field Coil.*

A suitably insulated and coiled conductor through which a magnet pole of a motor or generator may be energized. (Adopted Standard 10-30-1911.)

(1250) *Field Pole.*

A structure of magnetic material secured to or an integral part of the field frame on which a field coil may be mounted. The pole is always located between the field frame and the armature.

(Adopted Standard 11-18-1916.)

Reference Number

(1251) *Pole Shoe.*
The portion of a field magnet adjacent to the armature, whether integral with or attached to the pole. Its purpose is to secure proper distribution of the field flux. (Adopted Standard 11-18-1916.)

(1252) *Assembled Bearing Bracket or End Shield.*
A bearing bracket or end shield, respectively, together with its bearing sleeve and all parts associated therewith. (Adopted Standard 11-10-1915.)

(1253) *End Shield.*
A shield secured to the frame and adapted to support the bearing sleeve, but including no parts thereof and wholly or largely enclosing the end of the motor. (Adopted Standard 11-10-1915.)

(1254) *Bearing Bracket.*
A bracket of open construction secured to the frame to support the bearing sleeve, but including no parts thereof. (Adopted Standard Revised 11-10-1915.)

(1255) *Assembled Bearing Pedestal.*
A bearing pedestal together with its bearing sleeve and all parts accessory thereto.
(Adopted Standard 11-10-1915.)

(1256) *Bearing Pedestal.*
A bearing sleeve support, mounted on or constructed as a part of the base plate, but not including the bearing sleeve or any part thereof.
(Adopted Standard 11-10-1915.)

(1257) *Bearing Sleeve.*
The bushing, sleeve, box or shell within which the shaft rotates. (Adopted Standard 10-30-1911.)

(1258) *Oil Rings.*
The oil rings are usually of metal, loosely hung on the journal of an armature shaft, free to revolve thereon and therewith, located within the oil space of the bearing sleeve support and adapted to raise a lubricant from the oil cellar into which they dip to and distribute it on the journal of the shaft. (Adopted Standard 11-18-1916.)

(1259) *Brush Yoke.*
The rocker arm, ring, quadrant or other adjustable support for maintaining the brush studs or holders in their relative positions.
(Adopted Standard 10-30-1911.)

(1260) *Brush Holder.*
The device that holds the brush.
(Adopted Standard 10-30-1911.)

Reference Number

(1261) *Brush Holder Stud.*
The intermediate support between brush holder and brush yoke.
(Adopted Standard 10-30-1911.)

(1262) *Complete Armature.*
Armature ready to place in machine.
(Adopted Standard 10-30-1911.)

(1263) *Armature Core.*
Laminations assembled without slot insulation.
(Adopted Standard 10-30-1911.)

(1264) *Armature Quill.*
A ventilated or unventilated structure upon which an armature and commutator are assembled together, and which in turn may be mounted on the armature shaft.

Note: A quill may be an integral part of the armature and commutator, one or both, or the armature and commutator having been assembled separately, may be mounted together on the quill. (Adopted Standard 11-18-1916.)

(1265) *Armature Shaft.*

(1266) *Armature Sleeve.*
The unventilated support on which armature laminations are or may be mounted and which in turn is mounted on the armature shaft.
(Adopted Standard 10-30-1911.)

(1267) *Armature Spider.*
The ventilated support upon which armature laminations are mounted, and which in turn is mounted on the armature shaft.
(Adopted Standard 10-30-1911.)

(1268) *Commutator.*
An assembly of commutator bars suitably insulated in a shell or on a hub, ready for mounting on an armature shaft, sleeve or spider.
(Adopted Standard 10-30-1911.)

(1269) *Commutator Bars.*
The metal, current-carrying segments of a commutator. (Adopted Standard 10-30-1911.)

(1271) *Commutator Insulating Rings.*
All insulation between the ends of the assembled commutator bars and the ends of the supporting sheli, the end opposite to the armature core being known as the front end.
(Adopted Standard 10-30-1911.)

(1272) *Commutator Insulating Segments.*
The insulation between the sides of the commutator bars. (Adopted Standard 10-30-1911.)

Reference Number

(1273) *Commutator Filling.*

A complete assembled set of commutator bars and all insulation. (Adopted Standard 10-30-1911.)

(1274) *Commutator Shell.*

The metal support into which the commutator filling is assembled.

(Adopted Standard 10-30-1911.)

(1275) *Slip Rings.*

Rings suitably mounted on the rotating member of an alternating current machine serving with stationary brushes bearing thereon to conduct current into or out of said rotating member.

(Adopted Standard 11-10-1915.)

6. Single Phase Motor Parts

(1276) *Split Phase Winding.*

An auxiliary primary winding used in combination with the regular running winding in a single phase induction motor for the purpose of producing starting torque. (Adopted Standard 11-18-1916.)

(1277) *Centrifugal Starting Switch.*

A centrifugally operated automatic mechanism usually used in connection with split phase induction motors to open or disconnect the starting winding after the rotor has obtained a predetermined speed, and close or reconnect it prior to the time the rotor comes to rest. (Adopted Standard 11-18-1916.)

(1278) *Centrifugal Clutch.*

An automatic device often used with split phase motors which, below a predetermined speed, permits the rotating element of a motor to revolve free of the shaft, and which at that predetermined speed engages the shaft to make it turn with the rotating element and transmit the motor's power through it.

(Adopted Standard 11-18-1916.)

(1279) *Short Circuiter.*

A device operated by centrifugal force and used in connection with some forms of commutator type single phase motors to actuate the mechanism which short circuits the commutator bars. This short circuiter is also employed in some designs to raise the brushes from the commutator.

(Adopted Standard 11-18-1916.)

Reference Number

INDUSTRIAL CONTROL

(1500) *Electric Controller.*

A device, or group of devices, which serve to govern, in some predetermined manner, the electric power delivered to the device governed.

The device governed is usually a motor, but it was the intent of this definition to cover the control of generators, electric heating apparatus and any other devices requiring approximately the same kind of control as used for industrial motors.

(Adopted Standard 5-2-1916.)

(1501) *Full Magnetic Controller.*

A controller having all of its basic functions performed by electro-magnets.

(Adopted Standard 5-2-1916.)

(1502) *Manual Controller.*

A controller having all of its basic functions performed by hand. (Adopted Standard 5-2-1916.)

(1503) *Semi-Magnetic Controller.*

A controller having part of its basic functions performed by electro-magnets, and part by other means.

By basic functions is usually meant acceleration, retardation, line closing, reversing, etc.

(Adopted Standard 5-2-1916.)

(1504) *Master Switch.*

A device which serves to govern the operation of contactors and auxiliary devices of an electric controller.

A master switch may be automatic, as a float switch or pressure regulator. It may be manually operated, as a drum, push button or knife switch. (Adopted Standard 5-2-1916.)

(1505) *Magnetic Contactor.*

A magnetically actuated device for repeatedly establishing or interrupting an electric power circuit.

(Adopted Standard 5-2-1916.)

(1506) *Low Voltage Protection.*

The effect of a device operative on the reduction or failure of voltage to cause and maintain the interruption of power to the main circuit.

(Adopted Standard 5-2-1916.)

(1507) *Low Voltage Release.*

The effect of a device, operative on the reduction or failure of voltage, to cause the interruption of power to the main circuit but not to prevent the re-establishment of the main circuit on return of voltage. (Adopted Standard 5-2-1916.)

Reference Number

(1508) *Phase Failure Protection.*
The effect of a device, operative on the failure of power in one wire of a polyphase circuit, to cause and maintain the interruption of power on the remaining circuits. (Adopted Standard 5-2-1916.)

(1509) *Phase Reversal Protection.*
The effect of a device operative on the reversal of phase relations in a polyphase circuit to cause and maintain the interruption of power in all of the circuits. (Adopted Standard 5-2-1916.)

(1510) *Relay.*
A device which is operative by a variation in the characteristics of one electric circuit to effect the operation of other devices in the same or another electric circuit. (Adopted Standard 5-2-1916.)

(1511) *Resistance.*
The opposition offered by a substance or body to the passage through it of an electric current, converting electric energy into heat; the reciprocal of conductance. (Adopted Standard 5-2-1916.)

(1512) *Resistive Conductor.*
A conductor which is used on account of its property of resistance. (Adopted Standard 5-2-1916.)

(1513) *A Resistor.*
An aggregation of one or more units possessing the property of resistance. Used in an electric circuit for the purpose of operation, protection or control of that circuit. (Adopted Standard 5-2-1916.)

(1514) *Rheostat.*
A resistor provided with means for varying its resistance. (Adopted Standard 5-2-1916.)

(1515) *Constant Torque Resistor.*
A resistor for use in the armature or rotor circuit of a motor where the current remains practically constant throughout the entire speed range. (Adopted Standard 6-11-1917.)

(1516) *Fan Duty Resistor.*
A resistor for use in the armature or rotor circuit of a motor where the current is approximately proportional to the speed of a motor.
(Adopted Standard 6-11-1917.)

Reference Number

(1517) *Abbreviations.*

The following list of abbreviations shall be approved for use in industrial control diagrams:

Armature	Arm.
Ammeter	Am.
Voltmeter	Vm.
Indicating Wattmeter	Wm.
Integrating Wattmeter	Whm.
Power Factor Meter	Pfm.
Series Field	Serf.
Shunt Field	Shf.
Resistor	Res.
Brake	Br.
Rheostat	Rheo.
Switch	Sw.
Transformer	Trans.
Push Button	P.B.
Float Switch	Fl.Sw.

(Recommended Practice 6-11-1917.)

(1518) *Starter.*

An electric controller designed for accelerating a motor to normal speed in one direction of rotation.

NOTE—A controller designed for starting a motor in either direction of rotation includes the additional function of reversing. (Adopted Standard 5-23-1919.)

(1519) *Automatic Starter.*

A starter designed to automatically control the acceleration of a motor.

(Adopted Standard 5-23-1919.)

(1520) *Overload Protection.*

The effect secured by a device, operative on excessive current, to cause and maintain the interruption of current flow to the device governed. When it is a function of a controller for an electric motor the device employed shall provide for interrupting any operating overloads, but may not rupture short circuits. (Adopted Standard 5-23-1919.)

(1521) *Magnet Brake.*

A friction brake electro-magnetically controlled

(Adopted Standard 5-23-1919.)

(1522) *Wear Allowance.*

The total thickness of material, which may be worn away before the contact of two associated surfaces becomes ineffective.

(Adopted Standard 5-23-1919.)

Reference Number

(1523) *Pick-Up Voltage (or Current).*

The voltage (or current) at which a magnetic contactor starts to close under conditions of normal operating temperature.

(Adopted Standard 5-23-1919.)

(1524) *Sealing Voltage (or Current).*

The voltage (or current) necesary to seat the armature of a magnetic contactor from the position at which the contacts first touch each other, under conditions of normal operating temperature.

(Adopted Standard 5-23-1919.)

(1525) *Drop-Out Voltage (or Current).*

The voltage (or current) at which the contacts of a magnetic contactor open under conditions of normal operating temperature.

(Adopted Standard 5-23-1919.)

General Guarantee for Motors and Generators

Reference Number

(2001) *Rated Output.*

The manufacturer guarantees that apparatus manufactured by him will deliver successfully its rated output as indicated on the nameplate, provided said apparatus is properly cared for, operated under normal conditions and with competent supervision.

(Adopted Standard 11-10-1915.)

(2002) *Replacement of Defective Material.*

The manufacturer agrees to correct and shall have the right to correct by repair or replacement at his own expense, at his option f. o. b. his works, any defects in said apparatus which may develop under normal and proper use within six (6) months after date of shipment, when inspection proves the claims provided the purchaser gives the manufacturer immediate written notice of such defects, and provided further that during said period said apparatus is properly cared for, operated under normal condition, and with competent supervision. The correction of such defects by repair or replacement by the manufacturer shall constitute a fulfillment of all his obligations to the purchaser.

When apparatus is purchased and resold, the maximum guarantee period shall be twelve months from date of shipment from the works of the electrical apparatus manufacturer.

(Recommended Practice 11-10-1915.)

(2003) *Non-Responsibility for Damaged Apparatus.*

The manufacturer shall not be responsible for any damage resulting from improper storage or handling prior to placing the apparatus in service, and the manufacturer shall not assume any expense or liability for repairs made outside his works, without his written consent. (Adopted Standard 11-10-1915.)

(2004) *Liability for Consequential Damage.*

The manufacturer shall not be liable for consequential damage in case of any failure to meet the conditions of any guarantee.

(Adopted Standard Revised 11-10-1915.)

Reference Number

Furnishing Keys as Part of Shafts

(2005) All machines with keyways cut in the shaft extension for pulley, coupling, pinion, etc., shall be furnished with a key, unless otherwise specified by the customer. (Recommended Practice 11-17-1916.)

Government and Other Standard Specifications

(2025) When apparatus is built to meet the requirements of the government or other standard printed specifications, and the name plate clearly indicates the specifications to which the apparatus conforms, it is not necessary to include on the name plate the detailed information specified in The Electric Power Club rules. (Recommended Practice 6-11-1917.)

Standard Sizes for Circulars, Contract Forms, Price Forms and Engineering Data

(2501)

$8\frac{1}{2}'' \times 11''$ shall be used for circulars, contract forms, and such engineering data as are not intended to go with price sheets. Circulars shall be bound on the side. Contract forms and engineering data shall be bound on the end. 4"x7" shall be used for price forms and engineering data that accompany price forms. These shall be arranged for binding on the side in ring binders.

(Recommended Practice 11-9-1914.)

Reference Number

(3000)

MOTOR SERVICE RULES Of the N. E. L. A.

The rules governing the installation and use of motors on central station distributing systems have been endorsed as suggested practice by the Executive Committee of the National Electric Light Association, and have also been approved by the Electric Power Club. They are printed here for convenient reference:

The instantaneous current (determined by test or based on value guaranteed by manufacturer) drawn from the line by any motor (with the starting device, if any required, in the starting position) must not exceed the value for the rated horsepower of such motor as obtained from the following tables.

In a group installation the largest amount of starting current permitted by Tables "A" or "B" or "C" for any motor of the installation shall be the limit of starting current for any other motor of the group.

The limits of starting current in Table "B" are intended to be such that starting devices for polyphase motors will be required for motors above 5 H. P. where the installation consists of a single motor of such size. Instances may occur wherein it may be necessary to use a starting device on 5 H. P. motors. In any installation where starting devices are normally required, it shall be optional with the operating companies to approve the omission of the starting devices on motors of certain capacities.

Motors that cannot be safely subjected to full voltage at starting must be provided with a device to insure that on failure of voltage either

(a) The motor will be disconnected from the line, or

(b) The starting device will be returned to the starting position.

Reverse phase relays and circuit breakers or equivalent devices are recommended on all polyphase elevator installations, cranes and similar service to protect the installation in case of phase reversal.

Should special conditions seem to warrant an exception to the above rules the case must be referred to the company for consideration and decision.

Table "A"

Single Phase—Sixty Cycle

Maximum permissible starting current values for an installation of a single motor installed and connected to its load.

	Volts	*Amperes
½ H. P. and below	220	15
Above ½ H. P. to 1 H. P. inclusive	220	20
		*Amperes per H. P.
Above 1 H. P. to 5 H. P.	220	15
‡Above 5 H. P.	220	11

Motors requiring not more than *30 amperes starting current may be connected for 110 volt service.

The maximum size of a single-phase motor to be permitted on one phase of polyphase systems should be 5 H. P., larger sizes to be installed only after securing special permission.

*Current values are those indicated by a suitable well damped ammeter in the motor circuit on the line side of the starting device and are 75% of the permissible locked rotor values.

‡When desired to install single phase motors larger than 6 H. P. inquiry must be made of the operating company to determine if single phase current for this service is available.

Table "B"

Polyphase—Sixty Cycle

Maximum permissible starting current values for an installation of a single motor installed and connected to its load.

	Volts	*2 Phase Amps. Per Phase Per H. P.	*3 Phase Amps. Per Phase Per H. P.
1 H. P. and below	220	17.3	20
Above 1 H. P. to 2 H. P. inclusive	220	15.2	17.5
Above 2 H. P. to 5 H. P. inclusive	220	11.2	13
	440	5.6	6.5
	550	4.5	5.2
Above 5 H. P. to 30 H. P. inclusive	220	8	9
	440	4	4.5
	550	3.2	3.6
	2200	1	1
Above 30 H. P.	220	5.2	6
	440	2.6	3
	550	2.1	2.4
	2200	.5	.6

*Current values are those indicated by a suitable well damped ammeter in the motor circuit on the line side of the starting device, and are 75% of the ermissible locked rotor values.

Table "C"
Shunt and Compound Wound Direct Current Motors

Maximum permissible starting current values for an installation of a single motor installed and connected to its load.

	Volts	*Amperes Per H. P.
3 H. P. and below	230	12
	550	5
Above 3 H. P.	230	9
	550	4

*Current values are those indicated by a suitable well damped ammeter on the line side of the starting resistance.

No direct-current motor larger than ¾ H. P. may be connected to a 115 volt circuit.

Direct current 115 volt motors up to ½ H. P. shunt and ¾ H. P. compound wound, but in no case exceeding 30 amps. starting current, may be installed without starting resistance.

APPARATUS APPLICATION

Proper Selection of Apparatus

Reference Number (4001)

Extreme care should be used in the proper selection of apparatus in order that satisfactory operation and good service will result. Where the apparatus is subjected to unusual risk, the engineering department of the manufacturer should be consulted; especially where the apparatus is used under the following conditions:

Exposed to acid fumes,
Operating in damp places,
Where an exceedingly high speed is required,
Exposed to flour dust,
Exposed to gritty dust,
Exposed to steam,
Operated in poorly ventilated rooms,
Operated in pits, or where entirely enclosed in boxes,

Where operating temperature of the apparatus with overload guarantees applied exceeds 90° C.

(Adopted Standard 10-30-1911.)

GENERAL ENGINEERING RECOMMENDATIONS

Reference Number

GENERAL

Classification of Insulating Materials

5001) Insulating materials when considered in connection with temperature limits shall be classified as follows:

Class A. Cotton, silk, paper and similar materials, when so treated or impregnated as to increase the thermal limit, or when permanently immersed in oil; also enameled wire and enameled silk or cotton covered wire.

Class B. Mica, asbestos and other materials capable of resisting high temperatures, in which any Class A material or binder is used for structural purposes only, and may be destroyed without impairing the insulating or mechanical qualities of the insulation.

Class C. Fireproof and refractory materials, such as pure mica, porcelain, quartz, etc.

(Adopted Standard 11-9-1915.)

Impregnated means that the insulating material is thoroughly saturated but that in the case of coils the spaces between conductors are not necessarily completely filled.

Enameled wire, when silk or cotton covered, falls under Class A even if the fibrous covering is not treated, as this covering may be destroyed without imparing the insulation. (See A. I. E. E. Rules Nos. 375-392.)

Ambient Temperature

(5002) 1. The standard ambient temperature of reference, when the cooling medium is air, shall be 40° C.

See No. 7831 for Ambient Temperature of Reference for Mining Locomotives.

The Ambient Temperature of Reference means the maximum ambient temperature at which a piece of apparatus can operate successfully under full rated conditions. If this maximum ambient temperature is exceeded and the conditions or rating produce the permissible temperature rise, the maximum permissible actual temperature will be exceeded and deterioration of insulation result. Such a condition may also obtain in any piece of apparatus when it is operated within the maximum ambient temperature of 40° C. at voltages and frequencies other than normal. (Adopted Standard Revised 11-18-1916.)

2. A machine may be tested at any convenient ambient temperature but whatever be the value of this ambient temperature the permissible rises of temperature must not exceed those specified.

Reference Number

3. No correction need be made for the deviation of the ambient temperature of the cooling medium from the standard ambient temperature of reference.

(Adopted Standard 11-9-1915.)

See A. I. E. E. Rules Nos. 305, 307, 311 and 320. In the case of rotating machines cooled by forced draft a conventional weighted mean for the ambient temperature shall be employed, a weight of four being given to the temperature of the circulating air supplied through ducts and a weight of one to the surrounding room air.

ROTATING MACHINES

1. Standards of Rating Performance and Test Duration of Tests, or Time Ratings

(5300) Many machines are operated on a cycle of duty which repeats itself with more or less regularity. The heating of machines operating under such conditions is equivalent to a continuous run for a certain specified time. The standard duration of tests, or time ratings, for machines operating on such ratings shall be as follows:

5 min.
10 min.
15 min.
30 min.
60 min.
120 min.
Continuous.

Of these the first six are commonly known as Short Time Ratings. In every case the short time test shall commence only when the windings and other parts of the machine are within 5 degrees of the room temperature at the time of starting the test.

(Adopted Standard 11-9-1915.)

(See A. I. E. E. Rules Nos. 284, 285 and 286.)

Temperature Measurements

(5301) Temperatures herein referred to shall be measured by thermometer on all induction motors and on other motors and generators of less than 200 kw. or 200 H.P. output.

(Adopted Standard Revised 11-9-1915.)

Overload Temperature

(5302) The temperature of a machine when carrying overload shall be determined by starting the overload run not more than fifteen minutes after completing the test at rated load. Fifteen minutes shall be regarded as sufficient time within which to record result of rated load test. (Adopted Standard.)

Reference Number

(5303) **Temperature Ratings**

1. There may be two ratings for open type motors and generators with Class A insulation and continuous time ratings as follows:

(a) A rating giving a 40-Deg. C. temperature rise guarantee under continuous operation with a two-hour, 25 per cent overload guarantee at 55 Deg. C., to be designated and known as the 40 Deg. Rating.

(b) A rating giving a 50-Deg. C. temperature rise guarantee under continuous operation without overload temperature guarantee, to be designated and known as the 50-Deg. Rating.

2. Machines having 40-Deg. Ratings are designed for all classes of service, including those in which an overload capacity of 25 per cent for two hours is desired.

3. Machines having 50-Deg. Ratings are designed for conditions in which the load requirements are accurately known, and under which the machine will not be subjected to load in excess of its rating. Other ratings without overload temperature guarantee, which are designed for these same conditions or service, are:

Type	Class of Insulation	Time Rating	Temperature Rating
Open.....	A	Short-Time	50 Deg. C.
Semi-enclosed..	A	Any	50 Deg. C.
Enclosed.....	A	"	55 Deg. C.
Open.....	B	"	70 Deg. C.
Semi-enclosed..	B	"	70 Deg. C.
Enclosed.....	B	"	75 Deg. C.

A 50 degree open type continuous duty motor for general purposes as distinguished from a 50 degree special application motor described in the above rules is a "Recognized Departure" from the standards of The Electric Power Club. See page No. 177.

4. The temperature rating for which the machine is designed, including time rating and overload temperature guarantee, shall be clearly and specifically stated on all name-plates and in all bulletins, price sheets, quotations, specification sheets, etc.

(Adopted Standard 11-18-1916.)

2. Standard Manufacturing Practice

Tapered Shafts

(5400) The standard taper of shafts shall be at the rate of one and one-quarter inches in diameter per foot of length. (Recommended Practice 11-9-1914.)

Reference Number

Direction of Rotation

(5401) The standard direction of rotation for all non-reversing direct current motors and alternating current single phase motors shall be counter clockwise, and for all alternating current and direct current generators shall be clockwise viewed from the end of the machine opposite drive.

Unless otherwise specified, standard machines will be connected for standard direction of rotation.

(Recommended Practice 11-9-1915.)

Brush Dimensions

(5402) 1. Lengths of Round and Rectangular Brushes.

To 1¼″,	inclusive	Increase by steps of ⅛″
Over 1¼″ to 3″	"	" " " " ¼″
Over 3″		" " " " ½″

Wherever possible ¼″ steps are to be used below 1″ length and ½″ steps above 1″ length.

2. Width and Diameter.

Up to ¼″,	inclusive	Increase by steps of $\frac{1}{16}$″
Over ¼″ to 2½″	"	" " " " ⅛″
Over 2½″		" " " " ¼″
Diameter of all round brushes		" " " " $\frac{1}{16}$″

For widths ¼″ steps are to be used wherever possible.

3. Thickness.

Up to ¾″, inclusive	Increase by steps of $\frac{1}{16}$″
Over ¾″	" " " " ⅛″

Wherever possible ⅛″ steps are to be used above ½″ in thickness. Diameter of round brushes shall vary by steps of $\frac{1}{16}$″.

4. Limits.

(a) Rectangular and square brushes.

Length—plus or minus $\frac{1}{32}$″.

Width—exact size to $\frac{1}{64}$″ undersize.

Thickness—

Plain brushes +.001″
−.003″

Plated brushes +.001″
−.004″

For square brushes, thickness limits to apply to both width and thickness.

Reference Number

(b) Round Brushes.

Diameter	
Up to $\frac{1}{4}''$, inclusive	Exact size to .006″ undersize
$\frac{5}{16}''$ and $\frac{3}{8}''$ "	" " " .008″ "
$\frac{7}{16}''$ and above	" " " .010″ "

Length—plus or minus $\frac{1}{32}''$.

Box guages to be used for thickness and diameter.

5. Length of Flexible Shunts.

The length of a flexible shunt shall be the distance from the top of the brush to the center of the slot or hole in the terminal.

6. Holes or Slots in Terminals for Flexible Shunts.

Size of Screw	Maximum Size Hole or Slot
No. 8 and No. 10	$\frac{7}{32}''$
" 12 " 14	$\frac{1}{4}''$
$\frac{5}{16}''$ diameter	$\frac{11}{32}''$
$\frac{3}{8}''$ "	$\frac{13}{32}''$

Minimum size of hole or slot shall allow sufficient clearance to permit the screw entering the slot or hole without binding.

7. Bevels.

Bevels on carbon brushes shall vary by steps of 5°, and shall be accurate to within 1° above or below.

The length of a beveled brush shall be the distance from the end to the toe of the bevel, if beveled on one end only, or the distance from toe to toe measured parallel to the face of the brush when both ends are beveled. In other words, the length shall be that of the square ended brush from which the beveled brush was made.

8. Plated Brushes.

Dimensions, limits, etc., shall be the same as specified for plain brushes, except thickness limits for which see paragraph 4 above.

(Recommended Practice 11-18-1916.)

Terminals

(5403) Terminals.

Terminal connectors shall be standard for motors 5 H.P. 1750 R.P.M. up to and including 250 H.P. or 250 K.W. The use of terminal connectors on motors below 5 H. P., 1750 R.P.M., shall be optional with the manufacturer.

(Recommended Practice 11-13-1917.)

(5404) Terminal Markings.
(Recommended Practice Revised 5-30-1918.)

Standard Method of Terminal Marking and Connections.

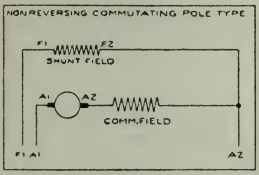
These markings are used only for terminals to which connection must be made from outside circuits or from auxilliary devices which must be disconnected for Shipment. They are not intended to be used for internal machine connections.

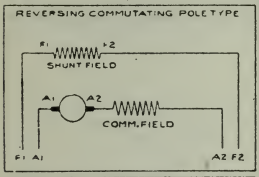
Single, Two and Three-phase Induction Motors.
D.C. Motors.
A.C. Generators.
D.C. Generators.
Transformers.
Control

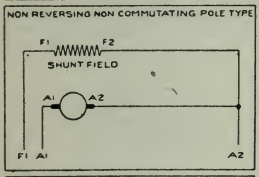
	D.C.	A.C.
Line	$L_1, L_2,$	$L_1, L_2, L_3,$ Etc.
Brush on Commutator	$A_1, A_2,$	$A_1, A_2, A_3,$ Etc.
Stator		$T_1, T_2, T_3,$ Etc.
Series Field	$S_1, S_2,$	
Brush on Slip Ring (Rotor)		$M_1, M_2, M_3,$ Etc
Shunt Field	$F_1, F_2,$	$F_1, F_2,$
Commutating Field	$C_1, C_2,$	
Braking	$B_1, B_2, B_3,$ Etc.	$B_1, B_2, B_3,$ Etc.
Armature Resistance	$R_1, R_2, R_3,$ Etc.	$R_1, R_2, R_3,$ Etc.
Shunt Field Resistance	$V_1, V_2, V_3,$ Etc.	
Transformer, High Voltage		$H_1, H_2, H_3,$ Etc.
Transformer, Low Voltage		$X_1, X_2, X_3,$ Etc.
Neutral Connection	Terminal letter with suffix 0.	

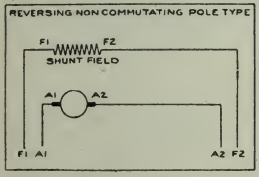
D.C. Motors, Shunt Wound

Rotation, Non Reversing Motors, Counter-clockwise Facing End Opposite Drive.
On Non Reversible Motor Starters Shunt Field Terminal Should Be Marked With The Word Field Machine Diagrams Will Not Show Control Connections Aways Start With A Free Lead Marked Sub. 1
All Internal Connections Go From Sub. 2 TO Sub 1





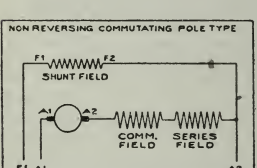




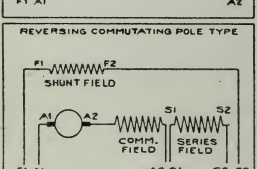
D.C.Motors,Compound Wound.

Rotation,Non ReversingMotors,Counter-clockwise FacingEnd Opposite Drive
On Non-reversible Motor Starters Shunt Field Terminal Should Be Marked
With The Word Field. Machine Diagrams Will Not Show Control Connections
Always Start With A Free Lead Marked Sub.1
All Internal Connections Go From Sub.2 To Sub.1

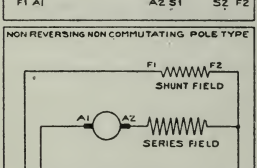
NON REVERSING COMMUTATING POLE TYPE



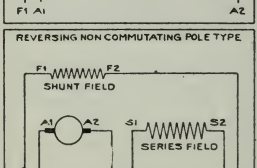
REVERSING COMMUTATING POLE TYPE



NON REVERSING NON COMMUTATING POLE TYPE



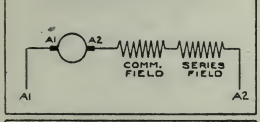
REVERSING NON COMMUTATING POLE TYPE



D.C. Motors, Series Wound.

Rotation, Non Reversing Motors, Counter-clockwise Facing End Opposite Drive
Machine Diagrams will Not Show Control Connections
Always Start With A Free Lead Marked Sub.1
All Internal Connections Go From Sub.2 To Sub.1

NON REVERSING COMMUTATING POLE TYPE



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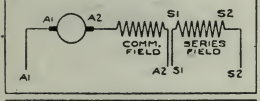
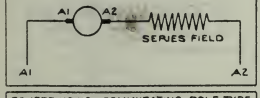


NON REVERSING NON COMMUTATING POLE TYPE



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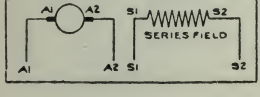
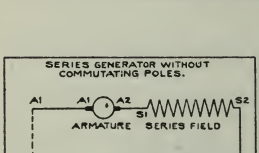
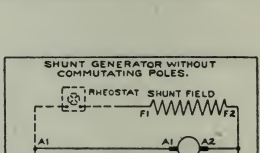
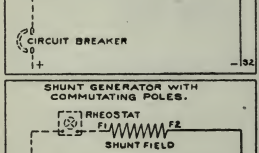


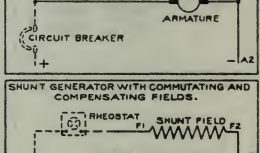
D.C. Generators, Two Wire.

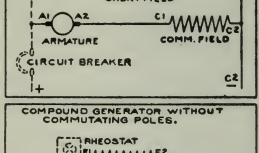
Direction of Rotation Clockwise Facing End Opposite Drive.

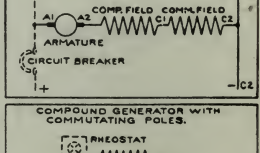


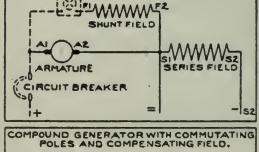






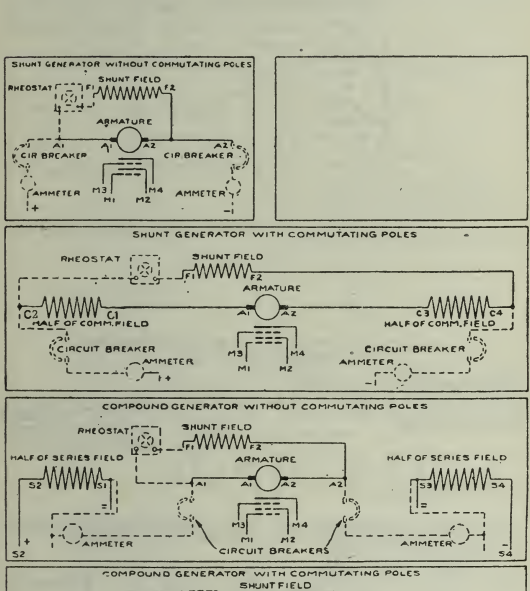




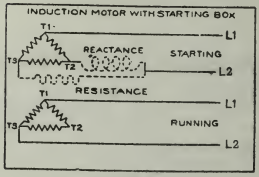


D.C. Generators, Three Wire.

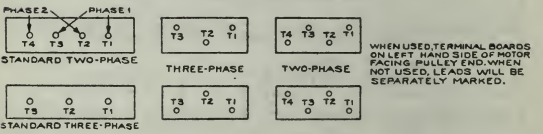
Direction of Rotation Clockwise Facing End Opposite Drive.

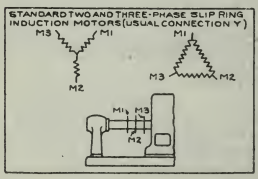


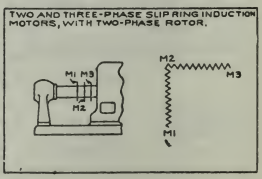
Induction Motor, Single-phase.



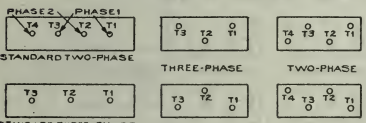
Induction Motors, Two and Three-phase Rotor Connection.





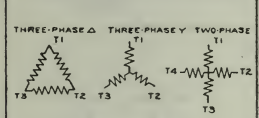


Induction Motors, Two and Three-phase. Stator Connections.

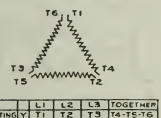


WHEN USED, TERMINAL BOARDS ON LEFT HAND SIDE OF MOTOR FACING PULLEY END, WHEN NOT USED, LEADS WILL BE SEPARATELY MARKED.

SINGLE SPEED, TWO AND THREE-PHASE

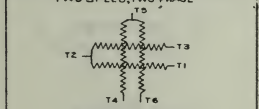


STARTING Y AND RUNNING Δ



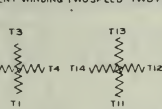
		L1	L2	L3	TOGETHER
STARTING	Y	T1	T2	T3	T4-T5-T6
RUNNING	Δ	T1-T6	T2-T4	T3-T5	

TWO SPEED, TWO-PHASE



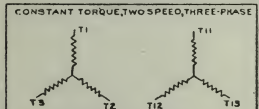
SPEED	L1	L3	L2	L4
LOW	T4	T6	T1	T3
HIGH	T5	T4-T6	T2	T1-T3

INDEPENDENT WINDING TWO SPEED TWO PHASE



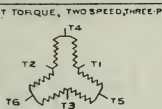
SPEED	L1	L2	L3	L4
LOW	T1	T2	T3	T4
HIGH	T11	T12	T13	T14

CONSTANT TORQUE, TWO SPEED, THREE-PHASE



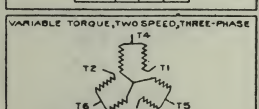
SPEED	L1	L2	L3
HIGH	T1	T2	T3
LOW	T11	T12	T13

CONSTANT TORQUE, TWO SPEED, THREE-PHASE



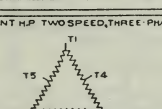
SPEED	L1	L2	L3	
LOW	T1	T2	T3	T4-T5-T6 OPEN
HIGH	T4	T5	T6	T1-T2-T3 TOGETHER

VARIABLE TORQUE, TWO SPEED, THREE-PHASE



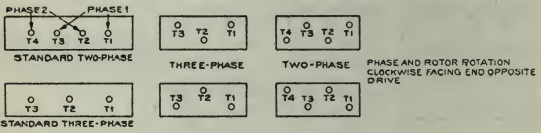
SPEED	L1	L2	L3	
LOW	T1	T2	T5	T4-T5-T6 OPEN
HIGH	T4	T5	T6	T1-T2-T3 TOGETHER

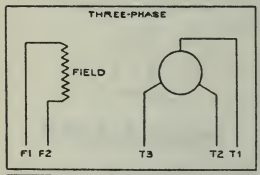
CONSTANT H.P TWO SPEED, THREE-PHASE

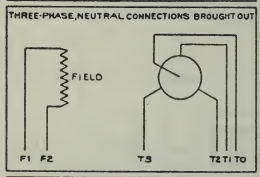


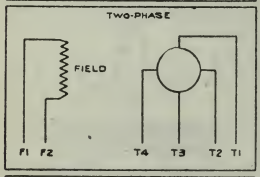
SPEED	L1	L2	L3	
LOW	T4	T5	T6	T1-T2-T3 TOGETHER
HIGH	T1	T2	T3	T4-T5-T6 OPEN

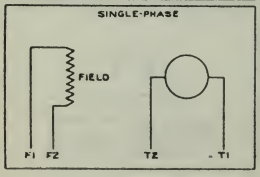
A.C. Generators and Synchronous Motors. Single-phase, Two-phase and Three-phase.











TRANSFORMER LEAD MARKINGS SINGLE PHASE TRANSFORMERS

SUBTRACTIVE POLARITY

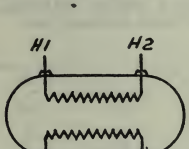


FIG. 1

ADDITIVE POLARITY

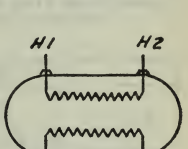


FIG. 2

SIMPLE HIGH AND LOW VOLTAGE WINDINGS WITHOUT TAPS

SUBTRACTIVE POLARITY

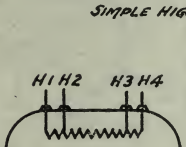


FIG. 3

ADDITIVE POLARITY

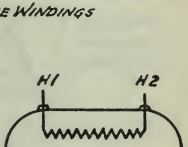
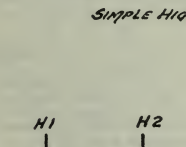


FIG. 4

SIMPLE HIGH AND LOW VOLTAGE WINDINGS WITH TAPS

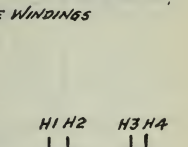
SUBTRACTIVE POLARITY



SERIES MULTIPLE LOW VOLTAGE WINDING WITHOUT TAPS.

FIG. 5

ADDITIVE POLARITY

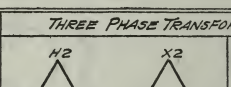
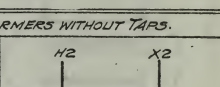
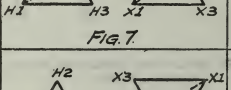
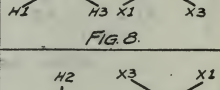
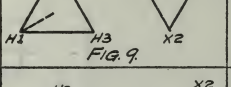
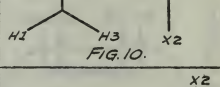
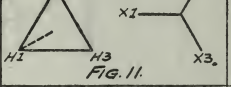
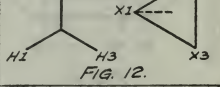
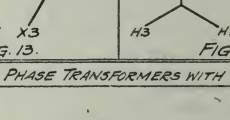


SERIES MULTIPLE LOW VOLTAGE WINDING WITH TAPS

FIG. 6

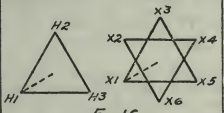
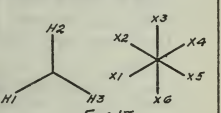
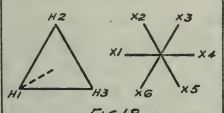
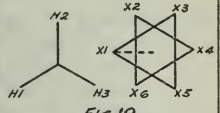
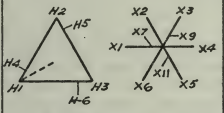
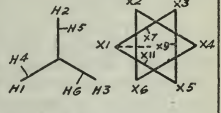
NOTE:—The above figures illustrate the application of the rules on lead markings to transformers having subtractive and additive polarity.

TRANSFORMER LEAD MARKINGS AND VOLTAGE VECTOR DIAGRAMS FOR THE USUAL THREE PHASE TRANSFORMER CONNECTIONS

	THREE PHASE TRANSFORMERS WITHOUT TAPS.	
GROUP-1 ANGULAR DISPLACEMENT 0°	 FIG. 7.	 FIG. 8.
GROUP-2 ANGULAR DISPLACEMENT 180°	 FIG. 9.	 FIG. 10.
GROUP-3 ANGULAR DISPLACEMENT 30°	 FIG. 11.	 FIG. 12.
	 FIG. 13.	 FIG. 14.
	THREE PHASE TRANSFORMERS WITH TAPS.	
GROUP-3 ANGULAR DISPLACEMENT 30°	 FIG. 15.	

NOTE:—The above figures are included to illustrated the method of marking transformer leads that are brought out of the case and are not intended to standardize connections, vector diagrams or polarity.

TRANSFORMER LEAD MARKINGS AND VOLTAGE VECTOR DIAGRAMS FOR THE USUAL SIX PHASE TRANSFORMER CONNECTIONS

	Six Phase Transformers Without Taps.	
Group 4 Angular Displacement 0°	 Fig. 16	 Fig. 17
Group 5 Angular Displacement 30°	 Fig. 18	 Fig. 19
	Six Phase Transformers With Taps.	
Group 5 Angular Displacement 30°	 Fig. 20	 Fig. 21

NOTE:—The above figures are included to illustrate the method of marking transformer leads that are brought out of the case and are not intended to standardize connections, vector diagrams or polarity.

CONSTANT POTENTIAL TRANSFORMERS

Standard Lead Markings

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*Rules for Transformer Lead Markings

(These rules do not apply to Auto Transformers.)

General

1. *Scope.* These rules specify the markings of leads brought out of the case but not the markings of winding terminals inside of the case, except that these terminals shall be marked with numbers in any manner that will permit of convenient reference and that cannot be confused with the markings of the leads brought out of the case.

NOTE.—It is recognized that special cases will arise from time to time that these rules will not cover and that it would be very difficult to cover by any set of general rules.

2. *Markings of Leads.*

(a) In General. The leads shall be distinguished from one another by marking each lead with a capital letter followed by a number. The letters to be used are H for high voltage leads, X for low voltage leads and Y for tertiary winding leads. The numbers to be used as 1, 2, 3, etc.

NOTE.—By "tertiary winding" is meant a third winding that, compared with both of the other two windings, has smaller Kv-a rating than either or, if the Kv-a rating is the same as one or both of the other two, has lower voltage.

E.g., if a transformer has three separate windings, one for 1000 Kv-a, 33000 volts, one for 600 Kv-a, 550 volts and one for 400 Kv-a 6600 volts, the 400 Kv-a winding is the tertiary winding.

Or, if a transformer has three separate windings each with a capacity of 1000 Kv-a, and with voltages of 33000, 6600 and 550 respectively, the 550 volt winding is the tertiary winding.

According to this definition neither one of two similar windings arranged for series-parallel connection is to be classed as a tertiary winding.

*In accordance with the recommendations of the General Conference Committee on Technical Subjects—February, 1918, with subsequent modifications. The Conference Committee represented the following associations: American Institute of Electrical Engineers, National Electric Light Association, The Electric Power Club and the Association of Edison Illuminating Companies.

(b) A neutral Lead shall be marked with the proper letter followed by O, e.g., HO, XO.

Exception.—A lead brought out from the middle of a winding for some other use than that of neutral lead, e.g., a 50% starting tap, shall be marked as a tap lead.

3. *Diagrammatic Sketch of Connections.*

The manufacturer shall furnish with each transformer a complete diagrammatic sketch showing the leads and internal connections and their markings and the voltages obtainable with the various connections.

This sketch should preferably be on a metal plate attached to the transformer case.

Single Phase Transformers

4. *Order of Numbering Leads in any Winding.*

The leads of any winding (high voltage, low voltage or tertiary) brought out of case shall be numbered 1, 2, 3, 4, 5, etc., the lowest and highest numbers marking the full winding and the intermediate numbers marking fractions of winding or taps. All numbers shall be so applied that the potential difference from any lead having a lower number toward any lead having a higher number shall have the same sign at any instant.

If a winding is divided into two or more parts for series parallel connections, and the leads of these parts are brought out of case, the above rule shall apply for the series connection with the addition that the leads of each portion of winding shall be given consecutive numbers. (Figs. 5 and 6.)

5. *Relation of Order of Numbering Leads of Different Windings.*

The numbering of the high voltage and low voltage leads shall be so applied that when H_1 and X_1 are connected together and voltage applied to the transformer, the voltage between the highest numbered H lead and the highest numbered X lead shall be less than the voltage of the full high voltage winding.

The same relation shall apply between high voltage and tertiary and low voltage and tertiary winding.

6. *Polarity.*

When leads are marked in accordance with the above rules, the polarity of a transformer is

Subtractive when H_1 and X_1 are adjacent (Figs. 1, 3 and 5).

Additive when H_1 is diagonally located with respect to X_1 (Figs. 2, 4 and 6).

7. *Location of H_1 Lead.*

To simplify the work of connecting transformers in parallel it is recommended that the H_1 lead shall be brought out on the right hand side of the case, facing high voltage side of the case.

8. *Parallel Operation.*

Transformers having leads marked in accordance with these rules may be operated in parallel by connecting similarly marked leads together, provided their ratios, voltages, resistances and reactances are such as to permit parallel operation.

In some cases design may be such as to permit parallel operation, although due to the difference in the number of tap leads, the leads to be connected together may not have the same number.

Three Phase Transformers.

9. *Marking of Full Winding Leads.*

The (3) high voltage leads and the (3) low voltage leads which connect to the full phase windings, shall be marked H_1, H_2, H_3 and X_1, X_2, X_3. The full phase winding of a tertiary winding shall be marked Y_1, Y_2, Y_3.

10. *Relation between High and Low Voltage Windings.*

(a) The markings shall be so applied that if the phase sequence of voltage on the high voltage side is in the time order H_1, H_2 H_3 it is in the time order of X_1, X_2, X_3 on the low voltage side and Y_1, Y_2 Y_3 for a tertiary winding.

(b) Angular Displacement.

In order that the markings of lead connections between phases shall indicate definite phase relations, they shall be made in accordance with one of the three-phase groups shown in Figs. 7 to 14, inclusive. The angular displacement between the high voltage and low volt-

age windings is the angle in each of the voltage vector diagrams (Figs. 7-14, inclusive) between the lines passing from its neutral point through H1 and X1, respectively.

Any three phase transformer having a delta Y connection may be represented by voltage vector diagram either in accordance with Figure 11 or Figure 13. Any three phase transformer having Y delta connection may be represented by voltage vector diagram either in accordance with Figure 12 or Figure 14. Since these voltage vector diagrams are equivalent, it is recommended that the terminal markings for three phase transformers having delta Y connection be always made in accordance with Figure 11 and that the terminal markings for three phase transformers having Y delta connection be always made in accordance with Figure 12.

11. *Tap Leads.*
    (a) Where tap leads are brought out of the case (neutral lead excepted) they shall be marked with the proper letter followed by the figures 4, 7, etc., for one phase, 5, 8, etc., for another phase, and 6, 9, etc., for the third phase. (See Fig. 15.)
    (b) Delta Connection. The order of numbering tap leads shall be as follows: 4, 7, etc., from lead 1 toward lead 2; 5, 8, etc., from lead 2 toward lead 3; and 6, 9, etc., from lead 3 toward lead 1. (See Fig. 15.)
    (c) Star Connection. The order of numbering tap leads shall be as follows: 4, 7, etc., from lead 1 towards neutral; 5, 8, etc., from lead 2 towards neutral; and 6, 9, etc., from lead 3 towards neutral. (See Fig. 15.)
12. *Interphase Connection Made Outside of Case.*
    Where the interphase connections are made outside of case, the leads will be marked with the proper letter followed by the numbers 1, 4, 7, 10, etc., for one phase; 2, 5, 8, 11, etc., for the second phase; and 3, 6, 9, 12, etc., for the third phase.
    The markings shall be so applied that when a star connection is made by joining together the highest numbered leads of each phase, all rules here given, excepting rule (2b) apply.

13. *Parallel Operation.*

Transformers having leads marked in accordance with these rules may be operated in parallel by connecting similarly marked leads together provided their angular displacements are the same and provided also their ratios, voltages, resistances, and reactances are such as to permit parallel operation.

NOTE.—In some cases designs may be such as to permit parallel operation although, due to a difference in the number of tap leads, the leads to be connected together are not similarly marked.

14. *Location of H1 Lead.*

To simplify the work of connecting transformers in parallel it is recommended that the H1 lead shall be brought out on the right hand side of the case, facing the high voltage side of the case.

Three Phase to Six Phase Transformers

15. *Rules for Three Phase Transformers that are Applicable.*

Rules 10b and 12 shall apply to three phase to six phase transformers. Rules 9 and 11 shall apply to three phase windings, but not to six phase windings.

16. *Markings of Six Phase Leads.*

The six leads which connect to the full phase windings shall be marked X1, X2, X3, X4, X5, X6. (Figs. 16-19 incl.)

17. *Relation Between Three Phase and Six Phase Windings.*

(a) The markings shall be so applied that if the phase sequence of voltage on the three phase side is in the time order H1, H2, H3, it is in the time order of X1, X2, X3, X4, X5, X6 on the six phase side.

(b) Angular Displacement.

In order that the markings of lead connections between phases shall indicate definite phase relations, they shall be made in accordance with one of the four, six phase groups shown in Figs. 16 to 19, inclusive. The angular displacement between the high voltage and low voltage windings is the angle in each of the voltage vector diagrams from its neutral through H1 and X1 respectively.

18. *Tap Leads.*

Where tap leads from low voltage windings are brought out of the case (neutral lead excepted), they shall be marked as follows:

(a) Diametrical Connection tap leads shall be marked from the two ends of each phase winding towards the middle or neutral point in the following order: X7, X13, etc., from X1 towards neutral; X8, X14, etc., from X2 towards neutral; X9, X15, etc., from X3 towards neutral; X10, X16, etc., from X4 towards neutral; X11, X17, etc., from X5 towards neutral; X12, X18, etc., from X6 towards neutral. (See Fig. 20.)

A tap from the middle point of any phase winding, not intended as a neutral, shall be given a number determined by counting from X1, X2 or X3 and not from X4, X5, or X6; e.g., if the only taps brought out are 50% starting taps, they shall be numbered X7, X8 and X9.

(b) Double Delta Connection. Tap leads shall be marked in the following order: X7, X13, etc., from X1 towards X3; X8, X14, etc., from X2 towards X4; X9, X15, etc., from X3 towards X5; X10, X16, etc., from X4 towards X6; X11, X17, etc., from X5 towards X1; X12, X18, etc., from X6 towards X2. (See Fig. 21.)

NOTE.—For starting purposes it is generally customary to bring out only two taps from one delta and start three-phase.

FRACTIONAL HORSE POWER DIRECT CURRENT MOTORS

Motors of less than 1 H. P.— see definition No. 1110

Reference Number

(6115) **RATING STANDARDS**

Voltage Ratings

(6117) Standard voltages shall be 32, 115 and 230 volts.

NOTE—The fields of 32 volt motors shall be so designed that they can be run continuously on 40 volts without injury.

(Adopted Standard Revised 1-15-1919.)

Load and Speed Ratings

(6119) 1. Standard load and speed ratings shall be:

Brake H. P. Ratings	Approx. Full Load R. P. M.
3/4	1725
1/2	1725 — 1140
1/4	1725 — 1140
1/6	1725 — 1140
1/8	1725 — 1140
1/12	1725
1/20	1725

(Recommended Practice 5-3-1916.)

2. When motors operating at other than the foregoing standard speeds are required, full load speeds approximating those of 25 or 60 cycle alternating current motors shall be given preference.

(Recommended Practice 5-22-1911.)

(6120) **STANDARD WINDINGS**

The standard windings for ½ and ¾ H.P. motors shall be both shunt and compound; for ¼. 1/6 and ⅛ H.P. motors, compound; for 1/12 and 1/20 H.P. shunt.

(Adopted Standard 1-15-1919.)

Reference Number

(6130) **PERFORMANCE SPECIFICATIONS**

(6131) **Temperature Rise**

Temperature Rise in degrees centigrade of all parts when operating under normal rated conditions as specified on the nameplate.

Class of insulation	A
Load, per cent of rated capacity	100
Time rating	Continuous
Open type	40°
Enclosed type	55°

(Adopted Standard Maximum Limit 10-30-1911.)

No overload temperature guarantee given.

For descriptive specification covering Class A insulation see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings, see No. 5303.

A 50 degree open type continuous duty motor for general purposes as distinguished from a 50 degree special application motor described in the above rules is a "Recognized Departure" from the standards of The Electric Power Club. See Page No. 177.

Change in Speed Due to Heating

(6139) Variation in speed from full load cold to full load hot during run of specified period shall not exceed 10 per cent, based on the full load speed hot.

(Adopted Standard Maximum Limit 5-3-1916.)

Dielectric Test

(6140) 1. Dielectric test for motors in capacities of ½ H. P. output (or 373 watts output) and larger shall be made by applying twice the normal voltage of the circuit to which the appratus is connected, plus 1,000 volts.

(Adopted Standard Minimum Limit 11-15-1916.)

2. Dielectric test for motors in capacities of less than ½ H. P. output (or 373 watts output), for operation upon circuits not exceeding 250 volts, shall be made by applying 900 volts. Motors above 250 volts shall be tested in accordance with first paragraph.

(Adopted Standard Minimum Limit 11-15-1916.)

Reference
Number

3. The specified A.C. test voltage shall be applied for one minute immediately after conclusion of the manufacturer's shop tests. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. All windings, except that under test, shall be connected to ground. The frequency of the testing circuit shall be 60 cycles, and the crest value of the total voltage shall be the square root of two, times the specified test voltage.

(Adopted Standard 5-30-1918.)

Equivalent Shop Test

For all motors manufactured in large quantities an A. C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

Allowable Variation from Rated Voltage

(6143) Motors shall operate successfully with normal rated current at any voltage not more than 10 per cent above or below normal, but not necessarily in accordance with the standards of performance established for operation at normal rating.

(Adopted Standard 5-3-1916.)

Allowable Variation from Rated Speed

(6144) At normal operating temperature and voltage, a variation of seven and one-half per cent (7½%) above or below any rated speed is permissible.

(Adopted Standard Maximum Limit Revised 5-3-1916.)

General Guarantee

(6149) See Nos. 2001 to 2004 incl.

(6170) STANDARD MANUFACTURING PRACTICE

Pulley Dimensions

(6171) Standard Pulley Dimensions shall be:

FLAT-FACED PULLEYS.

Dia.	Face	Bore.	Key.
3½″	2½″	¾″	$\frac{3}{16}$″ square
3 ″	2¼″	¾″	$\frac{3}{16}$″ square
2½″	1¾″	⅝″	$\frac{3}{16}$″ square

Reference Number

GROOVED PULLEYS.

Pitch Diam.	Belt Diam.	Bore	Set Screw.
2 "	5/16"	1/2"	5/16"—24 thread
1 5/8"	5/16"	1/2"	5/16"—24 thread
1 1/2"	1/4"	3/8"	5/16"—24 thread

NOTE.—The 1⅝x5/16" pulley, when used with a ¼" belt, gives pulley dimensions of 1½"x¼". Groove pulley should be arranged for mounting upon the shaft provided with a flat and secured by a set screw.

(Adopted Standard 5-7-1920.)

Shaft Diameters

(6172) Standard shaft diameters shall be as follows:

H. P.	Rated Speed	Shaft Extension Diameter
3/4	1725	¾-inch
1/2	1725	¾-inch
1/4	1725	⅝-inch
1/6	1725	½-inch
1/8	1725	½-inch
1/12	1725	½-inch
1/20	1725	⅜-inch

(Adopted Standard Revised 5-3-1916.)

Tolerance Limits in Dimensions

(6174) For belted type motors only, the allowable variation in the distance between the base of the motor and the center of the shaft, measured at the end of the shaft, shall be within the limits of plus 0 and minus 1/16". (Adopted Standard Maximum and Minimum Limits 5-3-1916.)

Name Plate Marking

(6175) The following minimum amount of information shall be given on all name plates:

(a) Manufacturers Type and Frame designation.
(b) Horse Power output.
(c) Time rating—See No. 5300.
(d) Temperature rise.
(e) R.P.M. at full load.
(f) Voltage.
(g) Full Load amperes.
(h) Winding—Shunt, compound or series.

(Recommended Practice Revised 6-11-1917.)

Direction of Rotation

(6178) See No. 5401.

Reference Number

Terminals

(6180) Terminals of Fractional Horsepower Motors shall consist of flexible single conductor leads brought out of the frame or bearing brackets of the motor through an insulated hole or holes, and any other form of connection shall be considered special and extra. Such terminals shall be approximately 9″ long for ¼ H.P. 1725 R. P. M. motors and smaller, and approximately 12″ long for sizes larger. (Adopted Standard 5-7-1920.)

Frame Designation

(6181) The stationary element or the name plate of each motor shall be marked with the manufacturer's frame designation. (Recommended Practice 5-13-1915.)

(6190) STANDARD COMMERCIAL PRACTICE

Resistance Starter

(6191) A resistance starter shall be standard for use with shunt wound and compound wound motors in capacities of ½ H. P. and larger.
(Recommended Practice 5-3-1916.)

FRACTIONAL HORSE POWER ALTERNATING CURRENT MOTORS

Motors of less than 1 H. P.— see definition No. 1110

Reference Number

(6201) **Classification of Single Phase Motors**

1. Commutator Type:
   (a) With commutator for starting only—constant speed.
   (b) With commutator for starting and running—constant and varying speed.
   (Adopted Standard 11-18-1916.)
2. Split Phase:
   (a) With clutch—constant speed.
   (b) Clutchless—constant speed.
   (Adopted Standard 11-18-1916.)

(6215) **RATING STANDARDS**

Voltage Ratings

(6217) Standard voltages shall be 110 and 220 volts. (Adopted Standard 6-8-1914.)

Frequencies

(6218) Standard frequencies shall be 25 and 60 cycles per second. (Adopted Standard.)

Load and Speed Ratings

(6219) Standard load and speed ratings shall be:

	60 Cycle Circuit		25 Cycle Circuit	
Brake H. P. Rating	Synchronous R. P. M.	Approximate Full Load R. P. M.	Synchronous R. P. M.	Approximate Full Load R. P. M.
3/4	1800	1725		
1/2	1800—1200	1725—1140	1500	1425
1/4	1800—1200	1725—1140	1500	1425
1/6	1800—1200	1725—1140	1500	1425
1/8	1800—1200	1725—1140	1500	1425
1/12	1800	1725	1500	1425
1/20	1800	1725	1500	1425

(Recommended Practice Revised 1-15-1919.)

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(6230) **PERFORMANCE SPECIFICATIONS**

(6231) **Temperature Rise**

Temperature Rise in degrees centigrade of all parts when operating under normal rated conditions as specified on the name plate.

Class of insulation	A
Load, % of rated capacity	100
Time rating	Continuous
Open type Enclosed type	40° 55°

(Adopted Standard Maximum Limit 10-30-1911.)

No overload temperature guarantee given.

For descriptive specification covering Class A insulation see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see No. 5303.

A 50 degree open type continuous duty motor for general purposes as distinguished from a 50 degree special application motor described in the above rules is a "Recognized Departure" from the standards of The Electric Power Club. See Page No. 177.

Dielectric Test

(6240) 1. Dielectric test for motors of ½ H. P. output (or 373 watts output) and larger, shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1,000 volts.

(Adopted Standard Minimum Limit 11-18-1916.)

2. Dielectric test for motors in capacities of less than ½ H. P. output (or 373 watts output), for operation upon circuits not exceeding 250 volts, shall be made by applying 900 volts. Motors above 250 volts shall be tested in accordance with first paragraph.

(Adopted Standard Minimum Limit 11-18-1916.)

3. The specified A.C. test voltage shall be applied for one minute immediately after conclusion of manufacturer's shop test. The test voltages shall be successively applied between each electric circuit and all other electric circuits and metal parts

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grounded. Inter-connected circuits are considered as one circuit. All windings except that under test should be connected to the ground. The frequency of the testing circuit shall be 60 cycles, and the crest value of the test voltage shall be the square root of two times the specified voltage.

(Adopted Standard 5-30-1918.)

Equivalent Shop Test

For all motors manufactured in large quantities an A.C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

Allowable Variation from Rated Voltage

(6243). Motors shall operate successfully with normal rated current and frequency at any voltage not more than 10% above or below normal, but not necessarily in accordance with the standards of performance established for operation at normal rating.

(Adopted Standard 5-3-1916.)

General Guarantee

(6249) See Nos. 2001 to 2004 incl.

(6270) STANDARD MANUFACTURING PRACTICE

Pulley Dimensions

(6271) Standard Pulley Dimensions shall be:

FLAT-FACED PULLEYS.

Dia.	Face	Bore.	Key.
3½"	2½"	¾"	$\frac{3}{16}$" square
3 "	2¼"	¾"	$\frac{3}{16}$" square
2½"	1¾"	⅝"	$\frac{3}{16}$" square

GROOVED PULLEYS.

Pitch Diam.	Belt Diam.	Bore	Set Screw.
2 "	$\frac{5}{16}$"	½"	$\frac{5}{16}$"—24 thread
1⅝"	$\frac{5}{16}$"	½"	$\frac{5}{16}$"—24 thread
1½"	¼"	⅜"	$\frac{5}{16}$"—24 thread

NOTE.—The 1⅝x5/16" pulley, when used with a ¼" belt, gives pulley dimensions of 1½"x¼". Groove pulley should be arranged for mounting upon the shaft provided with a flat and secured by a set screw.

(Adopted Standard 5-7-1920.)

Reference Number

Shaft Diameters

(6272) Standard shaft diameters shall be as follows:

H. P.	Rated Speed	Shaft Extension Diameter
3/4	1725	3/4-inch
1/2	1725	3/4-inch
1/4	1725	5/8-inch
1/6	1725	1/2-inch
1/8	1725	1/2-inch
1/12	1725	1/2-inch
1/20	1725	3/8-inch

(Adopted Standard Revised 5-3-1915.)

Tolerance Limits in Dimensions

(6274) For belted type motors only, the allowable variation in the distance between the base of the motor and the center of the shaft, measured at the end of the shaft, shall be within the limits of plus 0 and minus 1/16-inch. (Adopted Standard Maximum and Minimum Limits 5-3-1916.)

Name Plate Marking

(6275) The following minimum amount of information shall be given on all name plates:

(a) Manufacturers Type and Frame designation.
(b) Horse Power output.
(c) Time rating—See No. 5300.
(d) Temperature rise.
(e) R.P.M. at full load.
(f) Frequency.
(g) No. of phases.
(h) Voltage.
(i) Full load amperes.

(Recommended Practice Revised 6-11-1917.)

Direction of Rotation

(6278) For single phase motors see No. 5401.

Terminals

(6280) Terminals of Fractional Horsepower Motors shall consist of flexible single conductor leads brought out of the frame or bearing brackets of the motor through an insulated hole or holes, and any other form of connection shall be considered special and extra. Such terminals shall be approx-

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imately 9″ long for ¼ H.P. 1725 R. P. M. motors and smaller, and approximately 12″ long for sizes larger. (Adopted Standard 5-7-1920.)

Frame Designation

(6281) The stationary element or the name plate of each motor shall be marked with the manufacturer's frame designation.

(Recommended Practice Revised 5-13-1915.)

LARGE DIRECT CURRENT MOTORS

Motors 1 H. P. and larger — see definition No. 1111

Reference Number

(6315) **RATING STANDARDS**

Voltage Ratings

(6317) Standard voltages shall be 115, 230 and 550 volts.

NOTE—See Ref. No. 6319 for voltage limitations for standard H. P. and speed ratings.

(Adopted Standard Revised 11-9-1914.)

Load and Speed Ratings

(6319) 1. Standard load and speed ratings for open and semi-enclosed type continuous duty constant speed motors shall be as follows:

Table 1.—For General Application.

H.P.	R.P.M.	R.P.M.	R P.M.	R.P.M.
¾		1150		
1	1750	"		
1½	"	"		
2	"	"		
3	"	"		
5	"	"	850	
7½	"	"	"	
10	"	"	"	
15	"	"	"	
20	"	"	"	575
25	"	"	"	"
30	"	"	"	"
40	"	"	"	"
50		"	"	"
60		"	"	"
75		"	"	"
100		"	"	"
125			"	"
150			"	"
200			"	"

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Table 2.—For Direct Connection Only.

H.P.	R.P.M.	R.P.M.
50	1750	
60	"	
75	"	
100	"	
125	"	1150
150	"	"
200	"	"

Voltage ratings for the above are as follows:

115 volts from ¾ H.P. to 50 H.P., inclusive.

230 volts from ¾ H.P. to 200 H.P., inclusive.

550 volts from ¾ H. P. to 200 H. P., inclusive, but at this voltage the speed ratings will not conform definitely to listed speeds.

(Recommended Practice 5-7-1920.)

2. Standard load and speed ratings for adjustable speed open and semi-enclosed varying duty (machine tool) motors shall be as follows:

(a) Time Ratings:

Motors shall be given both a 60-minute and a continuous rating on the 50° basis, open and semi-enclosed, and on a 55° basis, enclosed. Both the 60-minute and the continuous rating shall be given on the nameplate. The horsepower ratings in this list shall be for 60-minute service and the continuous service horsepower ratings will be such as the motors will carry continuously at the temperature specified.

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(b) H.P. and Speed Ratings:

	3 to 1			4 to 1	
H.P.	RPM	RPM	H.P.	RPM	RPM
2	700	2100	2	500	2000
3	650	1950	3	500	2000
5	650	1950	5	450	1800
7½	600	1800	7½	450	1800
10	600	1800	10	400	1600
15	550	1650	15	400	1600
20	500	1500	20	400	1600
25	500	1500	25	400	1600
35	500	1500	35	300	1200
50	400	1200	50	300	1200

Voltage ratings for the above motors shall be 230 and 550 volts. (Recommended Practice 1-15-1919.)

Short Time Ratings

(6321) Standard short time ratings shall be 5, 10, 15, 30, 60 and 120 minutes. (See No. 5300.)

(Adopted Standard Revised 11-9-1915.)

Speed Ratios

(6322) Standard speed ratios for adjustable speed motors shall be 1 to 1½, 1 to 2, 1 to 3, and 1 to 4.

(Adopted Standard 10-30-1911.)

(6330) PERFORMANCE SPECIFICATIONS

Of 40° Rating Motors

A 40° Rating motor is an open type motor having a 4 C. temperature rise guarantee under continuous operation with a two-hour 25 per cent overload guarantee at 55° C. Detailed temperature guarantees and complete performance specifications are given below in paragraphs Nos. 6331 to 6349 inclusive. These apply to constant speed general purpose motors and adjustable speed and varying speed motors. (Adopted Standard.)

See No. 5303 for descriptive statement of this and other ratings.

Reference Number

(6331) **Temperature Rise**

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the nameplate.

Class of insulation	A	
Load, per cent of rated capacity	100	125
Time rating	Continuous	2 hrs.
1. *Core and Windings*	40°	55°
2. *Commutator*		
a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
3. *Bare Copper Windings*	50°	65°
3A. *Bare Copper Windings, Enclosed Motors* Provided the thermometer is applied directly to the surface of the bare copper winding.	65°	
4. *Mechanical Parts* *Temperature rise of all mechanical parts not in contact with the insulation may be such as will not be injurious in any respect.	*	*

(Adopted Standard except item 2 to be Maximum Limit Revised 11-18-1916.)

For descriptive specification covering classes of insulation, see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

Overload run immediately follows normal load run. See No. 5302.

For descriptive specifications covering temperature ratings see No. 5303.

Reference Number

Overload

(6332) 25% overload for two hours with the temperature guarantees given in No. 6331.
50% overload in torque momentarily without temperature guarantee.
(Adopted Standard Revised 11-18-1916.)

Change in Speed due to Load

(6338) The speed regulation of shunt wound constant speed continuous duty motors listed in Ref. 6319-1, from full load to no load hot, shall not exceed 12% on motors ¾ to 5 horse power, inclusive, and 10% on larger motors, based on full load speeds.
The speed regulation of shunt wound adjustable speed varying duty motors as listed in paragraph 6319-2, from full load to no load hot at any speed adjustment shall not exceed 22% on motors of 2 to 5 horse power, inclusive, and 15% on larger motors, based on full load speeds.
(Adopted Standard 5-23-1919, Revised 5-7-1920.)

Change in Speed due to Heating

(6339) Variation in speed from full load cold to full load hot, during run of specified period, shall not exceed 10% based on full load speed hot.
(Adopted Standard 11-10-1915.)

Dielectric Test

(6340) The standard dielectric test, except as specified below, shall be made by applying twice the normal voltage of the circuit to which the motor is connected, plus 1,000 volts. The A. C. test voltage is to be applied for one minute immediately after conclusion of the manufacturer's shop test. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. All windings, except that under test, shall be connected to ground. The frequency of the testing circuit shall be 60 cycles and the crest value of the test voltage shall be $\sqrt{2}$ times the specified test voltage.

Reference Number

Equivalent Shop Test

For all motors manufactured in large quantities and on which the A. C. test voltage is 2500 volts or less, an A.C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

(Adopted Standard Minimum Limit 5-3-1916.)

Allowable Variation from Rated Voltage

(6343) All motors shall operate successfully at normal rated load at any voltage not more than 10 per cent above or below the name plate rating, but not necessarily in accordance with the standards of performance established for operation at normal rating.

See No. 5002 (Adopted Standard 11-18-1916.)

Allowable Variation from Rated Speed

(6344) At normal operating temperature and voltage, the variation above or below rated speed shall not exceed 7½% for motors up to and including 7½ H. P.. 1150 R. P. M. For motors larger than 7½ H. P., 1150 R. P. M., this variation shall not exceed 5%, (Adopted Standard.5-3-1916.)

General Guarantee

(6349) See Nos. 2001 to 2004 incl.

PERFORMANCE SPECIFICATIONS of 50°, 55°, 70° and 75° Rating Motors

(6350) Motors with these ratings are without overload temperature guarantee as distinguished from the 40° Rating, which has an overload temperature guarantee. (See No. 6330.) Detailed temperature guarantees and complete performance specifications of the 50°, 55°, 70° and 75° Rating motors are given in Nos. 6351 to 6369 inclusive. These apply to motors of any speed classification, i. e., constant speed, adjustable speed, etc. (Adopted Standard 11-18-1916.)

See No. 5303 for descriptive statement of all ratings.

Reference Number (6351)

Temperature Rise

Temperature Rise in degrees centigrade when operating under normal conditions as specified on the nameplate.

Class of insulation	A	B
Load, per cent of rated capacity	100	100
Time rating *Time rating may be continuous or any standard short time rating. See No. 6321.	*	*
1. *Core and Windings* Fully enclosed motors. All other types.	55° 50°	75° 70°
2. *Commutators* a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator. b. In all other cases.	65° 85°	65° 85°
3. *Bare Copper Windings*	60°	80°
3A. *Bare Copper Windings, Enclosed Motors* Provided the thermometer is applied directly to the surface of the bare copper winding.	65°	85°
4. *Mechanical Parts* †Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.	†	†

(Adopted Standard except item 2 to be Maximum Limit Revised 1-15-1919.)

For descriptive specification covering classes of insulation, see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see No. 5303.

A 50 degree open type continuous duty motor for general purposes as distinguished from a 50 degree special application motor described in the above rules is a "Recognized Departure" from the standards of The Electric Power Club. See page No. 177.

Overload

(6352) 50% overload in torque momentarily without temperature guarantee.

(Adopted Standard 10-30-1911.)

Reference Number

Change in Speed due to Load

(6358) See Ref. No. 6338.

Change in Speed due to Heating

(6359) Variation in speed from full load cold to full load hot, during run of specified period, shall not exceed 15% for enclosed motors, or 10% for all other types, based on full load speed hot.

(Adopted Standard Revised 11-18-1916.)

Dielectric Test

(6360) See No. 6340.

Allowable Variation from Rated Voltage

(6363) See No. 6343.

Allowable Variation from Rated Speed

(6364) See No. 6344.

General Guarantee

(6369) See Nos. 2001 to 2004 inclusive.

(6370) STANDARD MANUFACTURING PRACTICE

Pulley Dimensions

(6371) Standard Pulley Dimensions shall be:

H.P. at 1750-1800 R.P.M	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R.P.M.	Diam.	Pulley Belt Width	Bore
1	¾		3	2	¾
1½	1		4	3	⅞
2	1½		4	3	1
5	3		5	4	1⅛
7½	5	3	5	4	1¼
10	7½	5	6	5	1⅜
15	10	7½	7	6	1⅝
20	15	10	8	6	1¾
25			9	7	1⅞
30	20	15	9	7	1⅞
40	25—30	20—25	10	7	2⅛
	40	30	11	10	2⅜
	50		12	11	2⅝
	60	40	12	11	2⅝
	75	50	13	12	2⅞
		60	13	12	2⅞
	100	75	15	14	

NOTE (A).—These pulley sizes are based on the use of paper pulleys.

NOTE (B).—These pulleys are applicable to either 40 deg. or 50 deg. motors.

(Recommended Practice 5-7-1920.)

Reference Number

Shaft Dimensions

(6372) Shaft extension sizes for constant speed general purpose motors shall be as follows:

H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	Shaft Extension Diam. in Inches	Key Width	Key Thickness
1	¾	¾	3/16	3/16
1½	1	⅞	3/16	3/16
2	1½	1	¼	¼
3	2	1	¼	¼
5	3	1⅛	¼	¼
7½	5	1¼	¼	¼
10	7½	1⅜	⅜	⅜
15	10	1⅝	⅜	⅜
20	15	1¾	⅜	⅜
25		1⅞	½	½
30	20	1⅞	½	½
40	25—30	2⅛	½	½
50		2⅛	½	½
	40	2⅜	½	½
	50	2⅝	¾	½
	60	2⅝	¾	½
	75	2⅞	¾	½
	100			

In case other diameters are used on specific ratings the selection of one of the listed sizes is recommended. The standard length of shaft extensions shall be three times the diameter.

(Recommended Practice 12-12-1919, Revised 5-7-1920.)

Taper Shafts

(6373) See No. 5400.

Tolerance Limits in Dimensions

(6374) The dimensions from shaft center to bottom of feet shall not be greater than the nominal dimensions shown on manufacturers' dimension sheet. Where the motor is to be mounted on other machinery and exact height of shaft is required, it is expected that shims will be used to secure accurate alignment.

(Adopted Standard Maximum 1-15-1919.)

Reference Number

Name Plate Marking

(6375) The following minimum amount of information shall be given on all nameplates:

(a) Manufacturers' type and frame designation.
(b) H. P. output.
(c) Time rating. (See No. 5300.)
(d) Temperature rise—normal.
(e) Overload.
(f) Time Rating of overload.
(g) Temperature rise for overload.
(h) R. P. M. at full load.
(i) Voltage.
(j) Full load amperes.
(k) Shunt, series or compound.

(Adopted Standard Revised 11-18-1916.)

NOTE—Items (e), (f) and (g) refer to overloads for which temperature guarantees are given.

Item (a) shall be optional for all constant speed general purpose motors and adjustable speed motors.

Direction of Rotation

(6378) See No. 5401. (Recommended Practice.)

Terminals for Cable Connections

(6380) Terminals for cable connections shall be furnished as standard with frames whose open continuous duty rating is approximately 5 H. P. at 1700 R. P. M. and larger. (Recommended Practice 11-10-1915.)

Outboard Bearings

(6383) 1. The use of outboard bearings is approved and recommended for general purpose motors with geared drive in frame sizes 75 H. P., 850 to 900 R. P. M., and larger.

This does not apply to mill type motors or others designed for special service where the heavy construction avoids the necessity for the outboard bearings.

2. The use of outboard bearings is approved and recommended for belted general purpose motors in frame sizes 250 H. P., 580 to 600 R. P. M. and larger.

It is not the intention to establish a definite dividing line below which it is not proposed to use outboard bearings, but rather to establish a dividing line which will indicate to the motor user what the manufacturers consider as good practice in general service. (Recommended Practice 5-3-1916.)

3. The use of outboard bearings is approved and recommended for general purpose motors with chain drive for frame sizes 75 H.P., 850 to 900 R.P.M., and larger.

(Recommended Practice 6-11-1917.)

LARGE ALTERNATING CURRENT MOTORS—SINGLE PHASE

Motors 1 H. P. and larger — see definition No. 1111

Reference Number

(6401) **Classification of Single Phase Motors**

1. Commutator Type.
   (a) With commutator for starting only—Constant Speed.
   (b) With commutator for starting and running—Constant Speed, Varying Speed.
2. Split Phase.
   (a) With clutch—Constant Speed.
   (b) Clutchless—Constant Speed.

(Adopted Standard 11-18-1916.)

(6415) **RATING STANDARDS**

Voltage Ratings

(6417) Standard voltages shall be 110 and 220 volts.
(Adopted Standard 6-8-1914.)

Frequencies

(6418) Standard frequencies shall be 25 and 60 cycles per second. (Adopted Standard.)

Load and Speed Ratings

(6419) Standard load and speed ratings shall be:

60 Cycles		25 Cycles	
H. P.	R. P. M.	H. P.	R. P. M.
¾	1200		
1	1800 — 1200	1	1500
1½	1800 — 1200	1½	1500
2	1800 — 1200	2	1500 — 750
3	1800 — 1200	3	1500 — 750
5	1800 — 1200 — 900	5	1500 — 750
7½	1800 — 1200 — 900	7½	1500 — 750
10	1800 — 1200 — 900	10	1500 — 750
15	1800 — 1200 — 900	15	1500 — 750
20	1800 — 1200 — 900	20	1500 — 750
25	1800 — 1200 — 900		
30	1800 — 1200 — 900		
40	1800 — 1200		
*50	1800		

Speeds given are synchronous speeds.

*For direct connection only.

(Recommended Practice 5-4-1916.)

Reference Number

(6430) **PERFORMANCE SPECIFICATIONS of 40° Rating Motors**

A 40° Rating motor is an open type motor having a 40° C. temperature rise guarantee under continuous operation with a two-hour 25 per cent overload guarantee at 55° C. Detailed temperature guarantees and complete performance specifications are given below in paragraphs Nos. 6431 to 6449 inclusive, These apply to constant speed general purpose motors and varying speed motors.

See No. 5303 for descriptive statement of this and other ratings.

(Adopted Standard.)

(6431) **Temperature Rise**

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the name plate.

Class of insulation	A	
Load, percent of rated capacity	100	125
Time rating	Continuous	2 hrs.
1. *Core and Windings*	40°	55°
2. *Squirrel Cage and Amortisseur Windings*	*	*
*Any value as will not occasion mechanical injury to the machine or cause deterioration of surrounding insulation.		
3. *Collector Rings*		
a. If Class A insulation is employed in the collector rings, or is adjacent thereto and its life would be affected by the heat from the collector rings.	65°	65°
b. If Class B insulation is employed in the collector rings or is adjacent thereto.	85°	85°
4. *Commutators*		
a. If Class A insulation is employed in the commutator or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
5. *Mechanical Parts*	**	**
**Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.		

(Adopted Standard, except items 3 and 4 are Maximum Limits Revised 11-18-1916.)

For descriptive specification covering classes of insulation, see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see No. 5303.

Overload run immediately follows normal load run. See No. 5302.

Reference Number

Overload

(6432) 25% overload for two hours with temperature guarantees given in No. 6431. 50% overload in torque momentarily without temperature guarantee.

(Adopted Standard 10-30-1911.)

Starting Torque

(6436) The starting torque of single phase motors, designed for repulsion start and induction running, with rated voltage and frequency applied, shall be not less than the following:

For 2 pole, 25 and 60 cycle				225%	of full load torque			
4	"	"	"	200%	"	"	"	"
6	"	"	"	175%	"	"	"	"
8	"	"	"	150%	"	"	"	"

(Adopted Standard 11-18-1916.)

Pull-in Torque

(6437) The pull-in torque of single phase motors, designed for repulsion start and induction running, with rated voltage and frequency applied, shall be not less than 110 per cent of full-load torque.

(Adopted Standard 11-18-1916.)

Maximum Running Torque

(6438) The pull-out or break-down torque of single phase motors, designed for repulsion start and induction running, with rated voltage applied, shall be not less than 175 per cent of full load torque.

(Adopted Standard 11-18-1916.)

Dielectric Tests

(6440) Dielectric tests, except as specified below, shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1,000 volts. The specified A. C. test voltage shall be applied for one minute immediately after the conclusion of the manufacturer's shop test. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. Inter-connected circuits are considered as one circuit. All windings except that under test shall be connected to ground. Frequency of testing circuit shall be 60 cycles, and the crest value of the test voltage shall be $\sqrt{2}$ times the specified voltage.

(Adopted Standard 11-18-1916.)

Equivalent Shop Test.

For all motors manufactured in large quantities and on which the A.C. test voltage is 2500 volts or less, an A.C.

Reference
Number

test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

(Adopted Standard Minimum Limit 11-18-1916.)

Exceptions: 1. The secondary windings of wound rotors not interconnected with stator windings shall be tested with twice their normal induced voltage, plus 1,000 volts.

(Adopted Standard Minimum Limit 11-18-1916.)

Allowable Variation from Rated Voltage

(6443) Motors shall operate successfully at rated load and frequency, with voltage not more than 10 per cent above or below the name-plate rating, but not necessarily in accordance with the standards established for operation at normal rating.

See No. 5002. (Adopted Standard 11-18-1916.)

Allowable Variation from Rated Frequency

(6444) Motors shall operate successfully at rated load and voltage, with frequencies not more than 5 per cent above or below the name-plate rating, but not necessarily in accordance with the standards established for operation at normal rating.

See No. 5002. (Adopted Standard 11-18-1916.)

Allowable Combined Variation of Voltage and Frequency

(6445) All motors shall operate successfully at rated load with a combined variation of voltage and frequency not more than 10 per cent above or below the name-plate rating, provided the variations given in Nos. 6443 and 6444 are not exceeded, but not necessarily in accordance with the standards established for operation at nomal rating.

See No. 5002. (Adopted Standard 11-18-1916.)

General Guarantee

(6449) See Nos. 2001 to 2004 inclusive.

(6450) PERFORMANCE SPECIFICATIONS of 50°, 55°, 70° and 75° Rating Motors

Motors with these ratings are without overload temperature guarantee as distinguished from the 40° Rating motors which have an overload guarantee. (See No. 6430). Detailed temperature guarantees and complete performance specifications of 50°, 55°, 70° and 75° Rating motors are given in Nos. 6451 to 6469 inclusive. These apply to motors of any speed classification, i. e., constant speed, varying speed, etc.

See No. 5303 for descriptive statement of all ratings.

(Adopted Standard 11-18-1916.)

Reference Number (6451)

Temperature Rise

Temperature Rise in degrees centigrade when operating under normal conditions as specified on the name plate.

Class of insulation	A	B
Load, percent of rated capacity	100	100
Time rating *Time rating may be continuous or any standard short time rating. See No. 5300.	*	*
1. *Core and Windings*		
a. Fully enclosed motors.	55°	75°
b. All other types.	50°	70°
2. *Squirrel Cage and Amortisseur Windings* **Any value as will not occasion mechanical injury to the machine or cause deterioration of surrounding insulation.	**	**
3. *Collector Rings*		
a. If Class A insulation is employed in the collector rings, or is adjacent thereto and its life would be affected by the heat from the collector rings.	65°	65°
b. If Class B insulation is employed in the collector rings, or is adjacent thereto.	85°	85°
4. *Commutators*		
a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
5. *Mechanical Parts* †Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.	†	†

(Adopted Standard, except Items 3 and 4, to be Maximum Limits 11-18-1916.)

For descriptive specification covering classes of insulation see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply, and deterioration of insulation may be expected if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see No. 5303.

A 50 degree open type continuous duty motor for general purposes as distinguished from a 50 degree special application motor described in the above rules is a "Recognized Departure" from the standards of The Electric Power Club. See page No. 177.

Reference Number

Overload

(6452) 50% overload in torque momentarily without temperature guarantee.

(Adopted Standard 11-18-1916.)

Starting Torque

(6456) For starting torque of continuous duty motors See No. 6436.

Pull-in Torque

(6457) For pull-in torque of continuous duty motors, See No. 6437.

Maximum Running Torque

(6458) For maximum running torque of continuous duty motors, See No. 6438.

Dielectric Tests

(6460) See No. 6440.

Allowable Variation from Rated Voltage

(6463) See No. 6443.

Allowable Variation from Rated Frequency

(6464) See No. 6444.

Allowable Combined Variation from Rated Voltage and Frequency

(6465) See No. 6445.

General Guarantee

(6469) See Nos. 2001 to 2004 inclusive.

(6470) STANDARD MANUFACTURING PRACTICE

Pulley Dimensions

(6471) Standard Pulley Dimensions shall be:

H.P. at 1750-1800 R.P.M	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R.P.M.	Pulley Diam.	Belt Width	Bore
1	¾		3	2	¾
1½	1		4	3	⅞
2	1½		4	3	1
5	3		5	4	1⅛
7½	5	3	5	4	1¼
10	7½	5	6	5	1⅜
15	10	7½	7	6	1⅝

Reference Number H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R.P.M.	Pulley Belt Diam.	Width	Bore
20	15	10	8	6	1¾
25			9	7	1⅞
30	20	15	9	7	1⅞
40	25—30	20—25	10	7	2⅛
	40	30	11	10	2⅜
	50		12	11	2⅝
	60	40	12	11	2⅝
	75	50	13	12	2⅞
		60	13	12	2⅞
	100	75	15	14	

NOTE (A).—These pulley sizes are based on the use of paper pulleys.

NOTE (B).—These pulleys are applicable to either 40 deg. or 50 deg. motors. (Recommended Practice 5-7-1920.)

Shaft Dimensions

(6472) Shaft extension sizes for constant speed general purpose motors shall be as follows:

H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	Shaft Extension Diam. in Inches	Key Width	Key Thickness
1	¾	¾	$\frac{3}{16}$	$\frac{3}{16}$
1½	1	⅞	$\frac{3}{16}$	$\frac{3}{16}$
2	1½	1	¼	¼
3	2	1	¼	¼
5	3	1⅛	¼	¼
7½	5	1¼	¼	¼
10	7½	1⅜	⅜	⅜
15	10	1⅝	⅜	⅜
20	15	1¾	⅜	⅜
25		1⅞	½	½
30	20	1⅞	½	½
40	25—30	2⅛	½	½
50		2⅛	½	½
	40	2⅜	½	½
	50	2⅝	¾	½
	60	2⅝	¾	½
	75	2⅞	¾	½
	100			

In case other diameters are used on specific ratings the selection of one of the listed sizes is recommended. The standard length of shaft extensions shall be three times the diameter.

(Recommended Practice 12-12-1919, Revised 5-7-1920.)

Reference Number

Taper Shafts

(6473) See No. 5400.

Tolerance Limits in Dimensions

(6474) The dimensions from shaft center to bottom of feet shall not be greater than the nominal dimensions shown on manufacturers' dimension sheet. Where the motor is to be mounted on other machinery and exact height of shaft is required, it is expected that shims will be used to secure accurate alignment.

(Adopted Standard 1-15-1919.)

Name Plate Markings

(6475) The following minimum amount of information shall be given on all name plates:

1. Motors without controller in secondary circuit.
   - (a) Manufacturers' type and frame designation.
   - (b) H. P. output.
   - (c) Time rating. (See No. 5300.)
   - (d) Temperature rise—normal.
   - (e) Overload.
   - (f) Time Rating of overload.
   - (g) Temperature rise for overload.
   - (h) R. P. M. at full load.
   - (i) Frequency.
   - (j) Number of phases.
   - (k) Voltage.
   - (l) Full load amperes.
2. Motors with controller in secondary circuit.
   - (a-l) Same as above.
   - (m) Secondary amperes at full load.

Items (e), (f) and (g) refer to overloads for which temperature guarantees are given.

Item (a) shall be optional.

(Adopted Standard Revised 11-18-1916.)

Direction of Rotation

(6478) See No. 5401.

LARGE ALTERNATING CURRENT MOTORS—POLYPHASE

Motors 1 H. P. and larger. See definition No. 1111

Reference Number

(6501) **Classification of Polyphase Motors**

1. Induction Motors:
   (a) Squirrel cage.
   (b) Slip ring.
   (c) Polar wound internally short circuited rotor.
2. Synchronous Motors.

(Adopted Standard 1-15-1919.)

(6515) **RATING STANDARDS**

Basis of Rating

(6516) 1. *Squirrel Cage Elevator Motors.*

Squirrel Cage Elevator Motors shall be rated primarily on the basis of guaranteed starting torque; they may also be given a H. P. rating. The H. P. Rating shall be the brake H. P. the motor will actually develop without exceeding the standard temperature rise for the standard time rating selected.

(Adopted Standard 5-4-1916.)

Voltage Ratings

(6517) Standard voltages shall be 110, 220, 440, 550 and 2200 volts.

NOTE—See Ref. 6519 for voltage limitations for various H. P. and speed ratings.

(Adopted Standard 5-30-1911.)

Frequencies

(6518) Standard frequencies shall be 25 and 60 cycles per second. (Adopted Standard.)

Load Ratings

(6519) Standard load and speed ratings for open and semi-enclosed continuous duty constant speed motors shall be:

Number of Poles	60 Cycle 4	6	8	10	12	16	25 Cycle 2	4	6
H. P.									
½								750	
¾		1200						"	
1	1800	"					1500	"	
1½	"	"					"	"	
2	"	"					"	"	

Reference Number	60 Cycle						25 Cycle		
Number of Poles	4	6	8	10	12	16	2	4	6
H. P.									
3	1800	1200	900				*1500	750	
5	"	"	"				"	"	
7½	"	"	"				"	"	
10	"	"	"		600		"	"	500
15	"	"	"		"		"	"	"
20	"	"	"		"		"	"	"
25	"	"	"		"		"	"	"
30	"	"	"		"		"	"	"
40	"	"	"		"		"	"	"
50		"	"		"		"	"	"
60		"	"		"		"	"	"
75		"	"		"			"	"
100		"	"		"	450		"	"
125			"	720	"	"		"	"
150			"	"	"	"		"	"
200			"	"	"	"		"	"

FOR DIRECT CONNECTION ONLY.

No. of Poles	60 Cycles. 4	6	25 Cycles. 2
H.P.	RPM	RPM	RPM
50	1800		
60	"		
75	"		1500
100	"		"
125	"	1200	"
150	"	"	"
200	"	"	"

The speeds given are synchronous speeds.

*1500 R.P.M. motors are for squirrel cage type only.

Add voltage ratings for the above as follows:
110 volts from ½ H.P. to 5 H.P., inclusive.
220 and 440 volts from ½ H.P. to 200 H.P., inclusive.
550 volts from ¾ H.P. to 200 H.P., inclusive.
2200 volts from 30 to 200 H.P., inclusive.

(Recommended Practice Revised 1-15-1919.)

(6530) PERFORMANCE SPECIFICATIONS of 40° Rating Motors

A 40° Rating motor is an open type motor having a 40° C. temperature rise guarantee under continuous operation with a two-hour 25 per cent overload guarantee at 55° C. Detailed temperature guarantees and complete performance specifications are given below in paragraphs Nos. 6531 to 6549 inclusive. These apply to motors of any speed classification, i. e., constant speed, varying speed, multi-speed, etc.

See No. 5303 for descriptive statement of this and other ratings.

Adopted Standard 11-18-1916.)

Reference Number

(6531)

Temperature Rise

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the name plate.

Class of insulation	A	
Load, percent of rated capacity	100	125
Time rating	Continuous	2 hrs.
1. *Core and Windings*	40°	55°
2. *Squirrel Cage and Amortisseur Windings*	*	*
*Any value as will not occasion mechanical injury to the machine or cause deterioration of surrounding insulation.		
3. *Collector Rings*		
a. If Class A insulation is employed in the collector rings, or is adjacent thereto and its life would be affected by the heat from the collector rings.	65°	65°
b. If Class B insulation is employed in the collector rings or is adjacent thereto.	85°	85°
4. *Commutators*		
a. If Class A insulation is employed in the commutator or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
5. *Mechanical Parts*	**	**
**Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.		

(Adopted Standard, except items 3 and 4 to be Maximum Limits, Revised 11-18-1916.)

For descriptive specification covering classes of insulation, see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply, and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see No. 5303.

Overload run immediately follows normal load run. See No. 5302.

Overload

(6532) 25% overload for two hours with temperature guarantees given in No. 6531.

50% overload momentarily in torque without temperature guarantee.

(Adopted Standard Revised 11-18-1916.)

Reference Number

Starting Torque

(6536) The starting torque of squirrel cage motors with rated voltage applied, at the instant of starting from rest, shall be not less than the following:

For	2	pole,	25 or 60	cycle	motors	150% of full load torque
	4	"	"	"		150% " "
	6	"	"	"		135% " "
	8	"	"	"		125% " "
	10	"	"	"		120% " "
	12	"	"	"		115% " "
	14	"	"	"		110% " "

With rated voltage applied, the torque shall at all speeds from zero to full load speed be not less than full-load torque.

(Adopted Standard Revised 5-23-1919.)

Maximum Running Torque

(6538) The pull-out or break-down torque, with rated voltage applied, shall be not less than 200 per cent of full-load torque.

(Adopted Standard Minimum Limit 11-18-1916.)

Dielectric Tests

(6540) Dielectric test, except as specified below, shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1000 volts. The specified A. C. test voltage is to be applied for one minute immediately after the conclusion of the manufacturer's shop test. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts grounded. Inter-connected polyphase windings are considered as one circuit. All windings except that under test shall be connected to ground. Frequency of the testing circuit shall be 60 cycles and the crest value of the test voltage shall be $\sqrt{2}$ times specified voltage.

(Adopted Standard 5-4-1916.)

Exceptions:

1. Field windings of synchronous motors which are to be started from alternating current circuits shall be tested as follows:

(a) When motors are started with fields short circuited, field windings shall be tested with 10 times the exciter voltage, but in no case less than 1500 volts nor more than 3500 volts.

(b) When motors are started with fields open circuited and sectionalized while starting, the field windings shall be tested with 5000 volts.

(c) When motors are started with fields open circuited and connected all in series while starting, the field windings shall be tested with 5000 volts for less than 275 volts

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Number

excitation and 8000 volts for excitation of 275 volts to 750 volts.

2. The secondary windings of wound rotors of induction motors shall be tested with twice their normal induced voltage, plus 1000 volts. When induction motors with phase wound rotors are reversed while running at approximately normal speed, by reversing the primary connections, the test shall be 4 times the normal induced voltage, plus 1000 volts.

Equivalent Shop Test

For all motors manufactured in large quantities and on which the A. C. test voltage is 2500 volts or less, an A.C. test voltage of 1.2 times the one minute test voltage specified above may be applied for one second as an alternative to the one minute test if desired.

Allowable Variation from Rated Voltage

(6543) All motors shall operate successfully at rated load and frequency with voltage not more than 10 per cent above or below name-plate rating, but not necessarily in accordance with the standards established for operation at normal rating.

See No. 5002. (Adopted Standard 11-18-1916.)

Allowable Variation from Rated Frequency

(6544) All motors shall operate successfully at rated load and voltage, with frequencies not more than 5 per cent above or below the name-plate rating, but not necessarily in accordance with the standards established for operation at normal rating.

See No. 5002. (Adopted Standard 11-18-1916.)

Allowable Combined Variation of Voltage and Frequency

(6545) All motors shall operate successfully at rated load with combined variation in voltage and frequency not more than 10 per cent above or below the name-plate rating, provided the limits of variations given in Nos. 6543 and 6544 are not exceeded, but not necessarily in accordance with the standards established for operation at normal rating.

See No. 5002. (Adopted Standard 11-18-1916.)

General Guarantee

(6549) See Nos. 2001 to 2004.

(6550) PERFORMANCE SPECIFICATIONS of 50°, 55°, 70° and 75° Rating Motors

Motors with these ratings are without overload temperature guarantee as distinguished from the 40° Rating motors which have an overload guarantee (See No. 6530). Detailed temperature guarantees and complete performance specifications of 50°, 55°, 70° and 75° Rating motors are given in Nos. 6551 to

6569 inclusive. These apply to motors of any speed classification, i. e., constant speed, varying speed, etc.
See No. 5303 for descriptive statement of all ratings.

(Adopted Standard 11-18-1916.)

(6551) **Temperature Rise**

Temperature Rise in degrees centigrade when operating under normal conditions as specified on the name plate.

Class of insulation	A	B
Load, percent of rated capacity	100	100
Time rating *Time rating may be continuous or any standard short time rating. See No. 5300.	*	*
1. *Core and Windings*		
a. Fully enclosed motors.	55°	75°
b. All other types.	50°	70°
2. *Squirrel Cage and Amortisseur Windings* **Any value as will not occasion mechanical injury to the machine or cause deterioration of surrounding insulation.	**	**
3. *Collector Rings*		
a. If Class A insulation is employed in the collector rings, or is adjacent thereto and its life would be affected by the heat from the collector rings.	65°	65°
b. If Class B insulation is employed in the collector rings, or is adjacent thereto.	85°	85°
4. *Commutators*		
a. If Class A insulation is employed in the commutator, or is adjacent thereto and its life would be affected by the heat from the commutator.	65°	65°
b. In all other cases.	85°	85°
5. *Mechanical Parts* †Temperature rise of all mechanical parts not in contact with insulation may be such as will not be injurious in any respect.	†	†

Adopted Standard, except Items 3 and 4, to be Maximum Limits 11-18-1916.)

For descriptive specification covering classes of insulation see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply, and deterioration of insulation may be expected if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see No. 5303.

A 50 degree open type continuous duty motor for general purposes as distinguished from a 50 degree special application motor described in the above rules is a "Recognized Departure" from the standards of The Electric Power Club. See page No. 177.

Reference Number

Overload

(6552) 50% overload momentarily in torque without temperature guarantee. (Adopted Standard 5-30-1911.)

Starting Torque

(6556) For starting torque of continuous duty motors, see No. 6536.

Maximum Running Torque

(6558) For maximum running torque of continuous duty motors, see No. 6538.

Dielectric Test

(6560) See No. 6540.

Allowable Variation from Rated Voltage

(6563) See No. 6543.

Allowable Variation from Rated Frequency

(6564) See No. 6544.

Allowable Combined Variation from Rated Voltage and Frequency

(6565) See No. 6545.

General Guarantee

(6569) See Nos. 2001 to 2004 inclusive.

(6570) STANDARD MANUFACTURING PRACTICE

Pulley Dimensions

(6571) Standard Pulley Dimensions shall be:

H.P. at 1750-1800 R.P.M	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R.P.M.	Pulley Diam.	Belt Width	Bore
1	¾		3	2	¾
1½	1		4	3	⅞
2	1½		4	3	1
5	3		5	4	1⅛
7½	5	3	5	4	1¼
10	7½	5	6	5	1⅜
15	10	7½	7	6	1⅝
20	15	10	8	6	1¾
25			9	7	1⅞

Reference Number H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	H.P. at 850-900 R.P.M.	Pulley Belt Diam.	Width	Bore
30	20	15	9	7	1⅞
40	25—30	20—25	10	7	2⅛
	40	30	11	10	2⅜
	50		12	11	2⅝
	60	40	12	11	2⅝
	75	50	13	12	2⅞
		60	13	12	2⅞
	100	75	15	14	

NOTE (A).—These pulley sizes are based on the use of paper pulleys.

NOTE (B).—These pulleys are applicable to either 40 deg. or 50 deg. motors.

(Recommended Practice 5-7-1920.)

Shaft Dimensions

(6572) Shaft extension sizes for constant speed general purpose motors shall be as follows:

H.P. at 1750-1800 R.P.M.	H.P. at 1150-1200 R.P.M.	Shaft Extension Diam. in Inches	Key Width	Key Thickness
1	¾	¾	$\frac{3}{16}$	$\frac{3}{16}$
1½	1	⅞	$\frac{3}{16}$	$\frac{3}{16}$
2	1½	1	¼	¼
3	2	1	¼	¼
5	3	1⅛	¼	¼
7½	5	1¼	¼	¼
10	7½	1⅜	⅜	⅜
15	10	1⅝	⅜	⅜
20	15	1¾	⅜	⅜
25		1⅞	½	½
30	20	1⅞	½	½
40	25—30	2⅛	½	½
50		2⅛	½	½
	40	2⅜	½	½
	50	2⅝	¾	½
	60	2⅝	¾	½
	75	2⅞	¾	½
	100			

In case other diameters are used on specific ratings the selection of one of the listed sizes is recommended. The standard length of shaft extensions shall be three times the diameter.

(Recommended Practice 12-12-1919, Revised 5-7-1920.)

Reference Number

Taper Shafts

(6573) See No. 5400.

Tolerance Limits in Dimensions

(6574) The dimensions from shaft center to bottom of feet shall not be greater than the nominal dimensions shown on manufacturers' dimension sheet. Where the motor is to be mounted on other machinery, and exact height of shaft is required, it is expected that shims will be used to secure accurate alignment.

(Adopted Standard 1-15-1919.)

Name Plate Marking

(6575) The following minimum amount of information shall be given on all name plates:

1. Induction Motors:
   - (a) Manufacturer's type and frame designation.
   - (b) H. P. output.
   - (c) Time rating. See No. 5300.
   - (d) Temperature rise—normal.
   - (e) Overload.
   - (f) Time rating of overload.
   - (g) Temperature rise for overload.
   - (h) R. P. M. at full load.
   - (i) Frequency.
   - (j) Number of phases.
   - (k) Voltage.
   - (l) Full load amperes.

   (Adopted Standard Revised 11-18-1916.)

NOTE—Item (a) shall be optional.

2. Wound Rotor Induction Motors:
   - (a-l) Same as above.
   - (m) Secondary amperes at full load.

   (Adopted Standard Revised 11-18-1916.)

NOTE—Item (a) shall be optional.

3. Synchronous Motors:
   - (a-l) Same as above.
   - (m) Maximum exciting current in amperes required to maintain the rated power factor and rated load.
   - (n) Excitation pressure in volts.

   (Adopted Standard Revised 11-18-1916.)

NOTE—Item (a) shall be optional.

Items (e), (f) and (g) refer to overloads for which temperature uarantees are given.

Reference
Number

4. Squirrel Cage High Torque Elevator Motors:
   (a) Manufacturers type designation.
   (b) H.P. rating (optional).
   (c) Time rating. See No. 5300.
   (d) Temperature rise (normal).
   (e) R.P.M. at full load.
   (f) Starting torque (lbs. at 1 ft.).
   (g) Frequency.
   (h) No. of phases.
   (i) Voltage.
   (j) Full load amperes.

(Adopted Standard Revised 11-12-1917.)

NOTE—Item (a) shall be optional.

Terminals for Cable Connections

(6580) Terminals for cable connections shall be furnished as standard practice with frames whose open continuous duty rating is approximately 5 H. P. at 1700 R. P. M. and larger.

(Recommended Practice 11-10-1915.)

Outboard Bearings

(6583) 1. The use of outboard bearings is approved and recommended for general purpose motors with geared or chain drive for frame sizes, 75 H.P., 850 to 900 R.P.M. and larger.

This does not apply to mill type motors or others designed for special service where heavy construction avoids the necessity for outboard bearings.

(Recommended Practice Revised 6-11-1917.)

2. The use of outboard bearings is approved and recommended for belted general purpose motors in frame sizes, 250 H. P., 580 to 600 R. P. M. and larger.

(Recommended Practice 5-4-1916.)

It is not the intention to establish a definite dividing line below which it is not proposed to use outboard bearings, but rather to establish a dividing line which will indicate to the motor user what the manufacturers consider as good practice in general service.

Reference Number

(6615) **RATING STANDARDS**

Capacity

(6616) 1. *Two-Wire Generators.*

The generator shall be rated in amperes corresponding to its standard voltage. Since the heating of the generator depends upon its current, the ampere ratings should not vary with any change in voltage on the standard machines. Example: A 50 kw. 250 volt generator has a normal capacity of 200 amperes. If such a machine is sold to operate at 235 volts either with reduction in speed or field excitation, the rated current capacity will still be 200 amperes.

(Adopted Standard 5-20-1912.)

2. *Three-Wire Generators.*

The ampere rating of a three-wire generator shall correspond to the ampere rating of a two-wire machine having an equal output at the same voltage. When such a generator is running with an unbalanced load, it shall be considered as delivering its rated load when the current on the more heavily loaded side is equal to the rated ampere output of the machine. The value of current in the neutral, or amount of unbalance, shall be expressed as a percentage of the rated load of the generator in amperes. A three-wire generator shall have a current capacity in the neutral of 10% of its rated capacity without exceeding the specified temperature limits.

(Adopted Standard Minimum Limit Revised 5-2-1916.)

Voltage Ratings

(6617) Standard voltages for general purpose generators shall be 125 and 250 volts at full load.

(Adopted Standard 5-7-1920.)

NOTE 1.—For 550 volt motor service generator of 600 volts at full load is recommended.

(Recommended practice 5-7-1920.)

NOTE 2.—For coal mine service, generator voltage of 275 volts at full load is recommended.

(Recommended practice 5-7-1920.)

Reference Number

(6630) **PERFORMANCE SPECIFICATIONS**

(6631) **Temperature Rise**

Temperature Rise in degrees centigrade when operating under normal rated conditions as specified on the name plate.

1. *Two-Wire Generators.*

Class of insulation	A	
Load, percent of rated current capacity	100	125
Time rating	Continuous	2 hrs.
Temperature Rise		
Core and Windings	40°	55°
Commutator	45°	60°

2. *Three-Wire Generators.*

The temperature guarantees specified for two-wire generators shall apply to three-wire generators, and to any auxiliary windings or devices required in adapting them to three-wire service. These temperature guarantees shall apply to such a generator whether carrying either a balanced or unbalanced load.

(Recommended Practice 5-20-1912.)

For descriptive specification covering classes of insulation see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002 for restrictions in this connection.

Overload run immediately follows normal load run. See No. 5302.

For descriptive specifications covering temperature ratings see No. 5303.

A 50 degree open type continuous duty generator for general purposes is a "Recognized Departure" from the standards of The Electric Power Club. See page No. 177.

Overload

(6632) 25% overload for 2 hours with temperature guarantee as given in No. 6631. 50% momentarily without temperature guarantee.

(Adopted Standard 5-20-1912.)

Commutation

(6633) A generator shall commutate throughout its range of rated capacity without adjustment of its brushes, and in such manner that neither brushes nor commutator are injured.

(Adopted Standard 5-20-1912.)

Reference Number

Compounding

(6634) Standard general purpose generators shall have compound windings such as to give, when operating at constant speeds, terminal voltages respectively as follows:

120 volts no load	125 volts full load
240 " " "	250 " " "
575 " " "	600 " " "

(Recommended Practice 5-7-1920.)

NOTE.—Generators for coal mine service shall be wound for 250 volts no load, 275 volts full load.
(Recommended Practice 5-7-1920.)

Voltage Regulation

(6635) The voltage regulation of a three-wire generator shall be such that when operating at rated current (on the heavier loaded side) and voltage and carrying in the neutral 10% of its rated amperes, the resulting difference in voltage between the two sides of the circuit will not exceed 2% of the normal rated voltage across the outside mains.
(Adopted Standard Maximum Limit, Revised 5-7-1920.)

Dielectric Test

(6640) The dielectric test for general purpose direct current generators shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1,000 volts (A. I. E. E. 500).
(Adopted Standard Minimum Limit 5-2-1916.)

Efficiency

(6648) 1. Conventional Efficiency shall be employed as distinguished from Directly-Measured Efficiency and shall be obtained in accordance with the rules of the A. I. E. E. (Adopted Standard 11-18-1916.)

See A. I. E. E. rules, Nos. 422, 423, 427, 432 and 440.

2. In determining the efficiency of a three-wire generator, all losses inherent in any auxiliary windings or devices required in adapting it to three-wire service shall be included as a part of the generator losses. Efficiency figures shall be determined on the basis of balanced load.
(Adopted Standard 5-20-1912.)

General Guarantee

(6649) See Nos. 2001 to 2004 incl.

Reference Number

(6670) STANDARD MANUFACTURING PRACTICE

Bore of Armature Spiders

(6673) Standard bores of armature spiders for engine type generators shall be:

		Side Crank	Center Crank
25 kw.	325 R.P.M.	4½″	4″
35 kw.	300 R.P.M.	5½″	4″
50 kw.	275 R.P.M.	6½″	4½″
75 kw.	275 R.P.M.	7½″	5½″
100 kw.	250 R.P.M.	8½″	6″
125 kw.	250 R.P.M.	8½″	6″
150 kw.	200 R.P.M.	10″	7″
150 kw.	150 R.P.M.	11″	8″
200 kw.	200 R.P.M.	11″	8″
200 kw.	150 R.P.M.	11″	8″
250 kw.	200 R.P.M.	13″	8″

NOTE—The standardization of load and speed ratings is under consideration and is not covered in rule.

(Recommended Practice 6-8-1914.)

Name Plate Markings

(6675) The following minimum amount of information shall be given on all name plates:

(a) Manufacturer's type designation and frame number.
(b) Kw. output.
(c) Time rating. See No. 5300.
(d) Temperature rise—normal
(e) Overload.
(f) Time rating of overload.
(g) Temperature rise for overload.
(h) Rated speed in R. P. M.
(i) Rated voltage*.
(j) Rated current in amperes.
(k) Winding—series, shunt or compound.

(Adopted Standard 11-18-1916.)

*Both full load and no load voltage to be given for compound wound generators.

Items (e), (f) and (g) refer to overloads for which temperature guarantees are given.

Item (a) shall be optional.

Direction of Rotation

(6678) See No. 5401.

Reference Number

(6690) STANDARD COMMERCIAL PRACTICE

Special Bores

(6691) Bores of armature spiders for engine type generators, differing from standard (See No. 6673), shall be considered a proper subject for an extra charge.
(Recommended Practice 6-8-1914.)

Witness Test

(6692) As manufacturers have found it advisable to make regular tests before any witness test is given, witness test shall be charged for.
(Recommended Practice 5-20-1912.)

Pressing Armature on Engine Shaft

(6693) It has been found good practice for the generator builder to press the engine shaft into the rotating member at his works. The charge for this work shall be included in the price of the generator and the engine builder shall include in the price of the engine the transportation charges on the shaft.
(Recommended Practice 5-20-1912.)

ALTERNATING CURRENT GENERATORS

(Exclusive of Turbo-Generators, Single Phase Alternators, Inductor Alternators, or Induction Generators.)

Reference Number

(6715) **RATING STANDARDS**

Basis of Rating

(6716) Alternating current generators shall be rated at the load that they are capable of carrying continuously without exceeding the temperature guarantees. The rating shall be expressed in kilovolt amperes available at the terminals at 0.8 power factor. Corresponding kilowatts should also be stated.

(Adopted Standard Revised 5-4-1916.)

It is recommended that the manufacturer's specification show the true kw. capacity of the machine in addition to other data.

Voltage Ratings

(6717) Standard voltages shall be 240, 480, 600 and 2400 volts. (Recommended Practice 6-8-1914.)

Frequencies

(6718) Standard frequencies shall be 25 and 60 cycles per second. (Adopted Standard 5-20-1912.)

Excitation Voltage

(6724) Standard excitation voltage for field windings shall be 125-volts direct current.

(Adopted Standard 5-20-1912.)

(6730) **PERFORMANCE SPECIFICATIONS**

(6731) **Temperature Rise**

Temperature Rise in degrees centigrade when operating at normal rating and power factor and under other normal conditions as specified on the name plate.

Class of insulation	A
Load, per cent of normal	100%
Power factor	80—100%
Time rating	Continuous
Temperature rise—core and winding	50°

(Recommended Practice 5-4-1916.)

Temperature guarantees for overload not to be given.

For descriptive specification covering classes of insulation, see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

Temperature specifications are limited to altitudes not exceeding 3300 feet.

All temperature rises are based on an ambient temperature of 40° C. See No. 5002 for restrictions in this connection.

For descriptive specifications covering temperature ratings see No. 5303.

Reference Number

Overload

(6732) Generators shall carry a momentary load of 150% of the normal ampere rating, the rheostat being set for rated load excitation. (A. I. E. E. 402.)
(Adopted Standard 5-4-1916.)

Excitation Voltage

(6733) The guarantees of operation given shall be met without excitation voltage exceeding standard. See No. 6724. (Recommended Practice 5-20-1912.)

Dielectric Test

(6740) The dielectric test for alternating current generators shall be made by applying twice the normal voltage of the circuit to which the apparatus is connected, plus 1000 volts, excepting that field windings shall be tested with 10 times the exciter voltage, but in no case less than 1500 volts nor more than 3500 volts. (A. I. E. E. 500 and 506.)
(Adopted Standard 5-4-1916.)

Power Factor

(6747) Standard general purpose alternators shall operate successfully at power factors at least as low as 0.8.
(Adopted Standard 5-4-1916.)

Efficiency

(6748) The efficiency of alternators shall correspond to the kilovolt amperes and power factor at which they are rated, and shall be the ratio of the energy output to the sum of the output and losses. The indeterminate losses may be assigned conventional values. The efficiency at all loads shall be corrected to a reference temperature of 75° C.
(Adopted Standard 5-4-1916.)

NOTE—The last sentence applies to 50 degree rated generators.

General Guarantee

(6749) See Nos. 2001 to 2004 incl.

Reference Number

(6770) STANDARD MANUFACTURING PRACTICE

Bore of Rotor

(6773) Maximum and minimum bores for rotors of engine type generators shall be:

Rating Kv-a.	RPM	Min. Size Dia.	Max. Size Dia.
50	300	4½	6½
75	300	4½	6½
100	300	6	8
125	300	6½	8½
75	277	6	8
100	277	6	8
125	277	6½	8½
75	257	6	8
100	257	6½	8½
150	257	6½	8½
250	257	8	10
312	257	10	12
125	225	7	9
150	200	8	10
200	200	8½	11
250	200	8	13
312	200	10	12½

(Recommended Practice 6-8-1914.)

NOTE—The standardization of load and speed ratings is under consideration and is not covered by this rule.

Name Plate Marking;

(6775) The following minimum amount of information shall be given on all name plates:

(a) Manufacturer's type designation and frame number.
(b) Kv-a. output.
(c) Power factor.
(d) Time rating. See No. 5300.
(e) Temperature rise—normal.
(f) Rated speed in R. P. M.
(g) Rated voltage.
(h) Rated current in amperes per terminal.
(i) Number of phases.
(j) Frequency in cycles per second.

NOTE—Item (a) shall be optional.

(Adopted Standard 6-10-1914.)

Direction of Rotation

(6778) See No. 5401.

Reference
Number

(6790) STANDARD COMMERCIAL PRACTICE

Special Bores

(6791) Bores of rotating members for engine type generators, differing from standard (See No. 6773), shall be considered a proper subject for an extra charge.
(Recommended Practice 6-8-1914.)

Pressing Rotor on Engine Shaft

(6793) It has been found good pratice for the generator builder to press the engine shaft into the rotating member at his works. The charge for this work shall be included in the price of the generator and the engine builder shall include in the price of the engine the transportation charges on the shaft.
(Recommended Practice 6-8-1914.)

MINING LOCOMOTIVES

Reference Number

(7800) GENERAL CLASSIFICATIONS

Types

(7801) A mining locomotive is defined as an electric locomotive so designed and constructed as to be applicable for use either in mines or primarily for other industrial purposes (as distinguished from what is ordinarily known as a railway locomotive) and of the mining type. (Adopted Standard 5-2-1916.)

(7815) RATING STANDARDS

Motor Rating

(7816) Mining locomotive motors shall be given Nominal Ratings which shall be the horse power output at the armature shaft, excluding gear and other transmission losses, which the motors will develop for one hour under normal rated conditions, on a stand test with covers removed and with natural ventilation, without exceeding the temperature rises guaranteed. See No. 7831. (Adopted Standard 5-2-1916.)

Voltage Ratings

(7817) Standard voltages shall be 250 and 500 volts.
(Adopted Standard 5-2-1916, Revised 5-7-1920.)

Sizes

(7819) Standard sizes shall be:

1. For single-motor locomotives, 1, 2½, 3, 4, 5, 6, 8, and 10 tons.
2. For two-motor locomotives, 4, 6, 8, 10, 13, 15, 20 and 25 tons.
3. For three-motor locomotives, 15, 20, 25, 30 and 35 tons.

(Adopted Standard 5-2-1916, Revised 5-7-1920.)

(7830) PERFORMANCE SPECIFICATIONS

Motor Temperature Rise

(7831) Under normal rated load and the conditions of stand test specified in Reference No. 7816, the temperature rises in degrees centigrade shall not exceed the following:

Commutator	90°
All other parts	75°

Temperature measurements by thermometer method, but in no case shall the resistance of any electrical circuit increase more than 40% during test.

Standard Ambient Temperature of Reference 25°C.

(Adopted Standard 5-2-1916.)

Reference Number

Locomotive Draw Bar Pull

(7836) The Draw Bar Pull on a straight and level track with dry, clean rails shall be determined as follows:

Running Draw Bar Pull, Steel Tread Wheels, 25% of weight of Locomotive.

Running Draw Bar Pull, Chilled Wheels, 20% of weight of Locomotive.

Starting Draw Bar Pull, (with sand), Steel Tread Wheels, 30% of weight of Locomotive.

Starting Draw Bar Pull (with sand), chilled Wheels, 25% of weight of Locomotive.

(Adopted Standard 5-2-1916, Revised 5-7-1920.)

Locomotive Performance Guarantee

(7849) Locomotive guarantee shall be based upon Draw Bar Pull in pounds on the level and speed in miles per hour that motors will develop as determined in accordance with No. 7816, making allowance of 5% for each spur gear transmission, and 7½% for each bevel gear transmission, and 1% of the weight of the locomotive loss of tractive effort in journals, flanges and all other losses.

(Adopted Standard 5-2-1916.)

The word transmission is understood to mean contact between any two gears.

(7870) STANDARD MANUFACTURING PRACTICE

Trolley Poles and Switches

(7871) The standard form of trolley pole for mining locomotive shall be the customary trailing wood pole wheel contact type.

A mining locomotive provided with more than one source of electrical supply, shall be provided, as standard equipment, with a switch of such character as to disconnect from the electric circuit of the locomotive, any current supply when it is not in use.

(Adopted Standard 5-2-1916.)

Headlight

(7872) The standard headlight shall be an incandescent headlight provided with a silvered parabolic reflector and using a concentrated filament incandescent lamp.

(Adopted Standard 11-15-1916.)

Reference Number

Track Gauges for Mines

(7873) In the interest of standardization of mining equipment, operators opening new mines are urged to adopt a track gauge of either 24 inches, 36 inches, or 42 inches, which shall be considered standard track guages for mines.

(Recommended Practice 11-15-1916.)

(7890) STANDARD COMMERCIAL PRACTICE

Storage Battery, Mining Locomotive Weights

(7891) The specification sheet incorporated in the propositions for storage battery mining locomotives shall set forth the nominal weight of the chassis, the listed weight of the storage battery, and the approximate weight of the locomotive, the latter figure being equal to the sum of the two preceding figures.

(Adopted Standard 11-15-1916.)

BUFFING AND GRINDING MOTORS

Reference Number

(7900) **GENERAL CLASSIFICATIONS**

Types

(7901) Buffing and grinding motors shall be divided into two classes:

(a) Grinding Motors.

(b) Buffing Motors.

Each class shall be divided into two groups:

(c) Bench Group.

(d) Floor Group.

(Adopted Standard 11-9-1914.)

(7915) **RATING STANDARDS**

Voltage Ratings

(7917) 1. Standard direct current voltages shall be 115 and 230 volts. (Adopted Standard 6-8-1914.)

2. Standard alternating current voltages shall be 110 and 220 volts.

(Adopted Standard 6-8-1914.)

Frequencies

(7918) Standard frequencies are 25 and 60 cycles per second. (Adopted Standard 6-8-1914.)

Speed Ratings—Grinding Motors

(7920) Standard no load hot speed ratings for Grinding Motors shall be:

Diameter Wheel Inches	Motor Speed D. C. R.P.M.	Motor Speed 60 cyc. R.P.M.	Motor Speed 25 cyc. R.P.M.	Motor Speed 30 cyc. R.P.M.	Motor Speed 40 cyc. R.P.M.
4	4000	3600	....	....	....
5	3500	3600	....	....	....
6	3000	3600	....	....	2400*
7	2600	....	....	....	2400
8	2200	1800*	....	....	2400
10	1800	1800	1500	1800	2400
12	1500	1800	1500	1800	1200*
14	1300	1200	1500	900*	1200
16	1100	1200	1500	900*	1200
18	1000	1200	....	900	1200
20	900	1200	750*	900	1200
22	825	900	750	900	800
24	750	900	750	900	800

*Gives a surface speed on the wheel of less than 4,000 feet per minute. Under these conditions the wheel wears rapidly and cuts inefficiently. These combinations are to be avoided wherever possible.

The table given above applies to vitrified and silicate straight wheels and tapered wheels. It does not apply to cup and cylinder wheels or to wheels of elastic, vulcanite, and other organic bonds

(Recommended Practice 11-10-1915.)

Reference Number

(7930) **PERFORMANCE SPECIFICATIONS**

(7931) **Temperature Rise**

Temperature Rise in degrees centigrade of all parts when operating under normal rated conditions as specified on the name plate.

Class of insulation	A
Load, per cent of rated	100
Time rating	Continuous
Grinding motors—enclosed type	55°

(Recommended Practice 5-4-1916.)

No overload temperature guarantee given.

For descriptive specification covering Class A insulation see No. 5001.

All temperature measurements by thermometer method. See No. 5301.

All temperature rises based on an ambient temperature of 40° C. See No. 5002. General guarantees do not apply and deterioration of insulation may be expected, if this ambient temperature is exceeded in regular operation.

For descriptive specifications covering temperature ratings see No. 5303.

Overload

(7932) Grinding motors shall carry a momentary load of 200% of the normal continuous rating.

(Adopted Standard 5-4-1916.)

(7970) **STANDARD MANUFACTURING PRACTICE**

Name Plate Marking

(7975) Name plates for grinding motors shall be marked:

a—Manufacturer's designation of types and frame sizes.

b—Horsepower output.

c—R. P. M. at no load.

d—Frequency, if alternating current.

e—Number of phases, if alternating current.

f—Voltage.

g—Rated load amperes.

*h—Basis of rating.

i—Serial number.

j—Winding (Shunt or Compound, if direct current).

(Adopted Standard 5-4-1916.)

*By "Basis of Rating" is meant that the nameplate must indicate that the rating is continuous. It is recognized, however, that the load of a grinding motor is extremely intermittent. It is therefore permissible to give, in addition, a short time rating, both rating and period to be shown.

NOTE—Item (a) shall be optional.

INDUSTRIAL CONTROL

DIAGRAMS

Marking End Connectors for Resistor Units

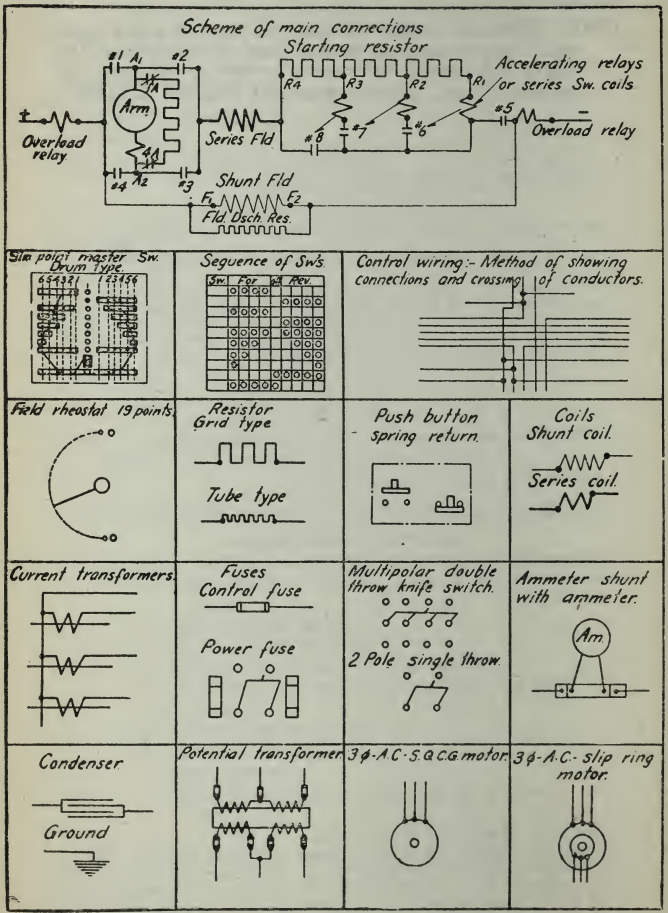
Reference Number

(8601) Where a resistor is made of two or more units and it is necessary to connect these units together, the use of the letters "A" to "A", "B" to "B", etc., is recommended. (Recommended Practice 5-2-1916.)

Reference Number

SYMBOLS

(8602) The following designating symbols shall be used on industrial control diagrams:



(Recommended Practice 6-11-1917.)

Reference Number

(8701) **Rating Standards**

(8702) *Basis of Rating*:

The rating of an industrial controller is based upon the class of service for which it can be used without exceeding the prescribed temperature limits. Overload capacity, where required, should be specified as an increased rating.

(Recommended Practice 5-23-1919.)

(8703) The following table gives service classifications of resistors:

Reference Number

Service Classification of Resistors by Numbers

Approximate per cent of full load current on the first point.	Light starting duty—15 sec. out of 4 min.	Heavy starting duty—30 sec. out of 4 min.	Light intermittent duty—one min. out of 4 min.	Heavy Intermittent duty—2 min. out of 4 min.	Continuous duty
25	#11	#31	#51	#71	#91
50	#12	#32	#52	#72	#92
70	#13	#33	#53	#73	#93
100	#14	#34	#54	#74	#94
150	#15	#35	#55	#75	#95
200 or over	#16	#36	#56	#76	#96

Note: 15 Sec. out of 4 Min. means that the resistor will operate at its specified duty not more than a total of 15 seconds during any 4 minute period.

(Recommended Practice 6-11-1917.)

Reference Number

"Starting and intermittent duty resistors in the classification table are primarily designed for use with motors requiring an initial torque corresponding to the current value for the class of resistor specified and requiring an average (root mean square) accelerating current not in excess of 125% of the full load value.

"Where a test is made without the motor, the resistor shall be connected to a voltage that will give the initial inrush current specified, and the steps shall be cut out at equal intervals in the 'time on' period of the cycle specified; the current at no time during the cutting out period to exceed 125% of the rated value. This test to be repeated every four minutes for one hour."

(Recommended Practice 5-23-1919.)

Range of Operating Voltage for Successful Operation of Contactors

(8704) D.C. contactors to be able to withstand 10% increased voltage without injury to the operating coils and to close successfully at 20% less than normal voltage.

A.C. contactors to be able to withstand 10% increased voltage without injury to the operating coils and to close successfully at 15% less than normal voltage.

For successful operation at the minimum voltage for continuous duty, the contactor coil should be subjected to the normal line voltage until constant temperature is reached, and then tested for successful closing at the minimum voltage.

(Adopted Standard 5-30-1918.)

(8705) Temperature of Resistors

The limiting observable temperature rise for resistors shall be 350 degrees C. when the thermometer can be placed against the resistive conductor, and 250 degrees C. when the thermometer is placed against the embedding material.

The limiting observable temperature rise for the issuing air shall be 175 degrees C. one inch from the enclosure.

Note.—All temperature measurements to be by thermometer method.

(Adopted Standard 5-30-1918.)

Reference Number

870 6) **Temperature of Contactors**

Operating Coils for Contactors: The limiting observable temperature rise of operating coils for magnetic contactors shall be 70 degrees C. when measured by thermometer.

Temperature of Contacts: The limiting observable temperature rise for the contacts of magnetic contactors shall be the following:

65 degrees C. rise for laminated contacts
100 degrees C. rise for solid contacts

Current-Carrying Parts Insulated with Asbestos or Other Fireproof Insulation: The limiting observable temperature rise for current-carrying parts insulated with asbestos or other fireproof material shall be 150 degrees C.

Note.—All temperature measurements to be by thermometer method.

(Adopted Standard 5-30-1918.)

(8707) **Temperature of Bus-Bars**

The limiting observable temperature rise of bus-bars on controller panels shall be 50° C. when measured by thermometer.

(Recommended Practice 5-23-1919.)

(8800) **SPECIFICATIONS FOR STANDARD INDUSTRIAL CONTROL EQUIPMENT**

(8801) **Overload Protection**

Overload protection above 5 H.P. 115 volts, or larger than 10 H.P., at the higher voltages, shall be provided by a contactor with overload relay or some sort of circuit breaker which shall respond to excessive current on one side of direct current and single phase alternating current circuits; and to excessive current in two sides of polyphase circuits. Fuses may be used for the protection of smaller motors.

(Recommended Practice 5-23-1919.)

(8802) **Under or Low Voltage Release or Protection**

Where restarting of a motor on restoration of voltage may cause damage or injury, low voltage protection shall be furnished. For all other cases either low voltage release or low voltage protection shall be furnished.

(Recommended Practice 5-23-1919.)

Reference Number

(8803) **Enclosing Cases.**

Standard enclosing cases shall be dustproof and splash-proof. (Recommended Practice 5-23-1919.)

(8804) **Non-Corrodible Material.**

Iron, steel, or other material with a suitable protective coating will be accepted as non-corrodible material. (Recommended Practice 5-23-1919.)

(8820) DETAIL SPECIFICATIONS FOR STANDARD STARTERS FOR GENERAL PURPOSE MOTORS

(8821) **Manual Starters for D. C. Motors.**

(a) Resistor Classification.
50 H.P. and below—No. 14 or No. 15. Ref. No. 8703.
Above 50 H.P.—No. 32, No. 33, No. 34 or No. 35. Ref. No. 8703.
(Recommended Practice 5-23-1919.)

(8822) **Automatic Starters for D. C. Motors.**

(a) Resistor Classifications, No. 35 or No. 36. Ref. No. 8703.
(Recommended Practice 5-23-1919.)

(8823) **Manual Starters for Wound Secondary Induction Motors.**

(a) Resistor Classification.
50 H.P. and below—No. 14 or No. 15. Ref. No. 8703.
Above 50 H.P.—No. 32, No. 33, No. 34 or No. 35. Ref. No. 8703.
(Recommended Practice 5-23-1919.)

(8824) **Automatic Starters for Wound Secondary Induction Motors.**

(a) Resistor Classification—No. 35 or No. 36. Ref. No. 8703.
(Recommended Practice 5-23-1919.)

Reference Number

RULES APPLICABLE ONLY TO DISTRIBUTION TRANSFORMERS FOR LIGHTING AND POWER SERVICE.

(Do not include those for special service, e.g., transformers for synchronous converters, instrument transformers, etc.)

(9001) **Classification.**

1. Distribution transformers shall include primarily those transformers in sizes 200 KVA and below which are used to step down from a distribution voltage to a standard service voltage, and shall also include transformers in sizse 200 KVA and below used to step down from a transmission voltage to a distribution voltage.

(Adopted Standard 11-11-1917.)

(9015) **Rating Standards.**

1. Tables Nos. 1 and 2 respectively (see pages 158 and 159), summarize the standard types, frequencies, KVA sizes, voltage ratings and taps for single and three-phase distribution transformers for supplying lighting and power service.

(Adopted Standard 1-13-1919.)

(9016) **Basis of Rating.**

1. In the case of standard transformers having single voltage rating and provided with taps, the maximum rated voltage shall always be considered the normal voltage rating. In the case of standard transformers having a double or a triple voltage rating, the voltage appearing in bold type shall be considered the normal voltage rating. Performance guarantees of such transformers shall be based on the normal voltage rating and full winding. (Exception see Temperature Rise Ref. 9031, also Dielectric Tests Ref. 9040.)

(Adopted Standard 11-11-1917.)

(9017) **Voltage Ratings.**

1. No definite standard transformer voltage ratings have yet been established for operation from standard system voltages of 44,000, 66,000, 88,000, 110,000, etc. (Adopted Standard 11-11-1917.)

Reference Number

2. Multiple connection for 1150 volts shall be omitted from standard transformers of the 2300-volt class. (Adopted Standard 11-11-1917.)

3. Multiple connection of the high voltage winding shall be omitted in standard transformers of the 6900-volt class or for higher voltages since taps are provided in the high voltage winding of such transformers. (Adopted Standard 11-11-1917.)

4. Series multiple connections of more than one combination, or of ratios other than 2:1, such as 110/220/440, 460/2300, 440/550/2200, are particularly undesirable from the standpoint of best transformer design and construction.
(Adopted Standard 11-11-1917.)

(9023) **Voltage Taps.**

1. Standard transformers wound for voltages below the 6600-volt class shall not be provided with taps. (Adopted Standard 11-11-1917.)

2. Standard single phase transformers of the 6600-volt class or for higher voltages shall be provided with taps in the high voltage winding for approximately 5 and 10 per cent voltage variation; and standard three phase transformers of the 6600-volt class or for higher voltages shall be provided with taps in the high voltage winding for approximately 10 per cent voltage variation.
(Adopted Standard 1-13-1919.)

3. Exception to this Rule is made only in the case of single phase transformers of the 6600-volt class for supplying service voltage 600 and below; present established practice necessitating the standardization of the following taps for such transformers:

6300/6000/5700 based on 6600 to 110/220 or to 220/440 or to 550-volt operation.

6585/6275/5960 based on 6900 to 115/230 or to 230/460 or to 575-volt operation.

6875/6545/6220 based on 7200 to 120/240 or to 240/480 or to 600-volt operation.
(Adopted Standard 11-11-1917.)

Reference Number

4. The low voltage windings of distribution transformers of standard voltage ratings for supplying service voltage 600 and below, shall not be provided with taps.

(Adopted Standard 11-11-1917.)

(9031) **Temperature Rise.**

1. The standard temperature rise at continuous rated KVA output shall be 55° C. This temperature rise guarantee shall apply irrespective of whether transformer is operated on full winding or on any tap of 10 per cent or less range.

(Adopted Standard 11-11-1917.)

2. Temperature rise of transformer windings shall be determined by the resistance method (A. I. E. E., Section 348).

(Adopted Standard 11-11-1917.)

3. Method of loading—(A. I. E. E., Sections 393 to 397, inclusive).

(Adopted Standard 11-11-1917.)

4. Temperature Co-Efficient of Copper—(A. I. E. E., Section 349).

(Adopted Standard 11-11-1917.)

5. Temperature of Oil—(A. I. E. E., Section 385).

(Adopted Standard 11-11-1917.)

6. When the elapsed time between the instant of shutdown and the time of final temperature measurement does not exceed three minutes, a correction of one degree per minute shall be added to the observed temperature rise.

(Adopted Standard 11-11-1917.)

(9035) **Regulation.**

1. The guarantee as to regulation shall be based on a reference temperature of 75° C.

(Adopted Standard 11-11-1917.)

2. The test as to the fulfillment of the regulation guarantee shall be made at any convenient temperature and corrected to a reference temperature of 75° C. (Adopted Standard 11-11-1917.)

Reference Number

3. Tests and computation of regulation for constant potential transformers for any specified load and power factor shall be computed from the measured impedance watts and impedance volts, as follows:

Let: P=Impedance watts, as measured in the short circuit test (See Ref. 9048).

E_z=Impedence volts, as measured in the short circuit test (See Ref. 9048.)

IX=Reactance drop in volts.

I=Rated primary current.

E=Rated primary voltage.

q_x=Per cent drop in quadrature with current.

q_r=Per cent drop in phase with current.

$$IX=\sqrt{E_x^2 \quad \left(\frac{P}{I}\right)^2}$$

$$q_r=100\frac{P}{EI}$$

$$q_x=100\frac{IX}{E}$$

Then A. For unity power factor we have approximately:

$$\text{Per cent regulation}=q_r+\frac{q_x^2}{200}$$

B. For inductive loads of power factor *m* and reactive factor *n*:

$$\text{Per cent regulation}=mq_r+nq_x+\frac{(mq_x-nq_r)}{200}$$

(Adopted Standard 11-11-1917.)

(9040) **Dielectric Tests.**

1. The standard values for insulation test voltages on distribution transformers other than small air-cooled transformers shall be as follows:

Reference Number

High Voltage Winding to Low Voltage Winding and Core.

Highest Operating Voltage.	Test Voltage.
Below 550 volts	4,000 volts
550 to 4,500 volts, inclusive	10,000 volts
Above 4,500 volts	Twice the highest Operating Voltage plus 1,000 volts.

Low Voltage Winding to Core.

Highest Operating Voltage.	Test Voltage
1,500 volts and below	4,000 volts
Above 1,500 to 4,500 volts, inclusive	10,000 volts
Above 4,500 volts	Twice the highest Operating Voltage of the Low Voltage Winding plus 1,000 volts.

(Adopted Standard 1-13-1919.)

2. Transformers intended for Y connection shall have their test voltages determined by the line voltage and not the leg voltage. For example: Distribution transformers of the 6600-volt class shall be given a test from high voltage winding to low voltage winding and core of 26,000 volts as it is common practice to connect these transformers in Y for operation at 12,470 volts.

(Adopted Standard 11-11-1917.)

3. Dielectric tests shall be made as outlined below:

a. Between high voltage and low voltage windings.

b. Between high voltage winding and the core. (a) and (b) may be made at the same time by connecting the low voltage windings to the core.

c. Between the low voltage winding and the core. (Adopted Standard 11-11-1917.)

4. The time of application for each test as outlined in preceding paragraphs of this section shall be one minute.

(Adopted Standard 5-30-1918.)

Reference Number

5. Measurement of voltage in making dielectric tests shall be in accordance with A. I. E. E. Sections 530 to 541, inclusive.

(Adopted Standard 11-11-1917.)

(9048) **Losses and Efficiency.**

1. Guarantees as to losses shall be based upon a reference temperature of 75° C.

(Adopted Standard 11-11-1917.)

2. All losses shall be guaranteed on the basis of measure with a true sine wave.

(Adopted Standard 11-11-1917.)

3. If the wave form of the circuit employed for test differs from the sine wave, reference to A. I. E. E. Section 406 shall be made to determine whether such variation exceeds that permissible.

(Adopted Standard 11-11-1917.)

4. Transformer losses shall be considered under two divisions: No load losses and load losses.

(Adopted Standard 11-11-1917.)

5. No load losses shall be the losses measured by wattmeter when normal rated voltage at rated frequency is applied to either winding, the other winding being open circuited. Since there is no appreciable variation of no load losses due to temperature changes, within the limits of operating temperatures, the test may be made at any convenient temperature without the necessity for correction by referring measured values to the standard reference temperature of 75° C. (A. I. E. E. Section 445).

(Adopted Standard 11-11-1917.)

6. Load losses shall be the losses measured by wattmeter when adequate voltage is applied to primary winding to produce rated current in the secondary winding, the latter being short circuited. (Either the high voltage or the low voltage winding may be used as the primary.) Tests may be made at any convenient temperature and corrected to the standard reference temperature of 75° C. (A. I. E. E. Section 445).

(Adopted Standard 11-11-1917.)

Reference Number

7. Tolerance Factors—

No load losses.....10%
Load losses 5%

(Adopted Standard 11-11-1917.)

8. On orders covering three or less units the above tolerances shall apply to each unit, but if an order covers more than three units, the tolerances shall apply to the individual units only. The obligation in the latter case shall be that the average losses of all the units on a particular order shall represent guaranteed values, and that no tolerance factors shall be applied to this average.

(Adopted Standard 11-11-1917.)

9. Efficiency = [KVA Output (100% Power factor)] ÷[KVA Output (100% Power Factor)+Total Losses at 75° C.]

Total losses shall be obtained as outlined in preceding paragraphs of this Section.

(Adopted Standard 11-11-1917.)

10. All day efficiency, unless otherwise specified, shall be calculated on a basis of four hours full load and twenty hours no load.

(Adopted Standard 11-11-1917.)

(9076) **Terminal Markings.**

1. For method of marking transformer terminals see General Engineering Recommendations Ref. 5404. (Adopted Standard 5-30-1918.)

(9077) **Transformer Polarity.**

Subtractive Polarity will be standard for all single phase transformers in sizes 200 KVA and smaller whose high voltage ratings are above 7500 volts.

For single phase transformers in sizes 200 KVA and smaller whose high voltage ratings are 7500 volts and below, it is recommended that the manufacturers use their present practice with regard to polarity.

(Adopted Standard 5-5-1920, to take effect January 1, 1921.)

(9079) **Transformer Accessories**

Standard accessories for single phase distribution transformers, sizes 200 KVA and smaller, will be in accordance with Table No. 3 (see page 160). (Adopted Standard 5-5-1920, to take effect January 1, 1921.)

Reference Number (9015)

TRANSFORM

THREE PHASE DISTR

SIZES 200 KV
FOR SUPPLYING LIGHT
STANDARD TYPES, FREQUENCI

STANDA
Oil Immerse

STANDARD
25 Cycle
60 Cycle

STANDARD SIZES IN KV-A. CONTI

5–7.5–10–15–25–37

NOTE.—See following Table for sizes that

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF

Standard System Voltages	Standard Sizes for Each Voltage Class	Transf for Sta
		On I Win
2300	5 to 200 incl.	2200/38 **2300/40** 2400/41
4600	5 to 200 incl.	4400Y **4600Y** 4800Y
6600	10 to 200 incl.	6600Y **6900Y** 7200Y
11000	10 to 200 incl.	11000Y **11500Y**
13200	10 to 200 incl.	13200Y **13800Y**
22000	15 to 200 incl.	22000Y **23000Y**
33000	37.5 to 200 incl.	33000Y **34500Y**
		NOTE.—All size multiple t

NOTE.—Voltage ratings in bold type will be considered the normal voltage ratings of thes
however, that where a transformer is suitable for operation at two voltage ratir
the connection diagram or on a paster inside the transformer cover.

Standard transformers having voltage ratings listed above will be designed for full r

In general standard three-phase distribution transformers are not suitable for mu
displacement, turn ratio and impedance volts on which successful multiple operatio

SINGLE PHASE DISTRIBUTION TRANSFORMERS

SIZES 200 KV-A. AND BELOW
FOR SUPPLYING LIGHTING AND POWER SERVICE
STANDARD TYPES, FREQUENCIES, SIZES AND VOLTAGE RATINGS

STANDARD TYPES
Oil Immersed—Self Cooled

STANDARD FREQUENCIES
25 Cycles per Second
60 Cycles per Second

STANDARD SIZES IN KV-A. CONTINUOUS RATINGS AT 55 DEG. C. RISE

1.5–2.5–3–5–7.5–10–15–25–37.5–50–75–100–150–200

NOTE.—See following Table for sizes that are standard for the various system voltages.

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF TRANSFORMERS FOR THE VARIOUS SYSTEM VOLTAGES

Standard System Voltages	Standard Sizes for Each Voltage Class	For Supplying Service Voltages 600 and Below: Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately on Taps			Transformer Low Voltage Ratings for Supplying Service Voltages 600 and Below	For Supplying Distribution Voltages Above 600: Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately — On 5% Tap	On 10% Tap	Transformer Low Voltage Ratings for Supplying Nominal 2300- or 4000-volt Distribution
440	1.5–3 to 100 incl.	440 **460** 480				...to 110/220 ...to **115/230** ...to 120/240				
550	1.5–3 to 100 incl.	550 **575** 600				...to 110/220 ...to **115/230** ...to 120/240				
2300	1.5–3 to 200 incl.	2200 **2300** 2400				...to 110/220 ...or to 220/440 ...or to 550 ...to **115/230** ...or to **230/460** ...or to **575** ...to 120/240 ...or to 240/480 ...or to 600				
4600	1.5–3 to 200 incl.	2200/4400 **2300/4600** 2400/4800				...to 110/220 ...to **115/230** ...to 120/240				
6600	1.5–3 to 200 incl.	6600/11430Y **6900/11950Y** 7200/12470Y	6300 6585 6875	6000 6275 6545	5700 (use) 5960 (use) 6220 (use)	...to 110/220 ...or to 220/440 ...or to 550 ...to **115/230** ...or to **230/460** ...or to **575** ...to 120/240 ...or to 240/480 ...or to 600	**6600/11430Y**	6270	5940	.....to **2300** (see Note)
11000	2.5–5–10 to 200 incl.	11000 **11500**	10450 10925	9900 10350		...to 110/220 ...or to 220/440 ...or to 550 ...to **115/230** ...or to **230/460** ...or to **575**	**11000**	10450	9900	.....to **2300/4000Y**
13200	2.5–5–10 to 200 incl.	13200 **13800**	12540 13110	11880 12420		...to 110/220 ...or to 220/440 ...or to 550 ...to **115/230** ...or to **230/460** ...or to **575**	**13200**	12540	11880	.....to **2300/4000Y**
22000	5–10 to 200 incl.	22000 **23000**	20900 21850	19800 20700		...to 110/220 ...or to 220/440 ...or to 550 ...to **115/230** ...or to **230/460** ...or to **575**	**22000**	20900	19800	.....to **2300/4000Y**
33000	10 to 200 incl.	33000 **34500**	31350 32775	29700 31050		...to 110/220 ...or to 220/440 ...or to 550 ...to **115/230** ...or to **230/460** ...or to **575**	**33000**	31350	29700	.....to **2300/4000Y**

NOTE.—Transformers having low voltage rating of 115/230 for sizes 100 kv-a. and below are arranged for series, multiple or three-wire service by connection of the low voltage leads outside of the transformer tank; whereas, sizes 150 and 200 kv-a. are suitable for series or three-wire service only. Transformers having low voltage rating of 230/460 for sizes 200 kv-a. and below, are suitable for series or multiple service only.

These odd taps for distribution transformers of the 6600-volt class are chosen because of present established practice.

NOTE.—Standard Single-phase Distribution Transformers for supplying nominal 2300- or 4000-volt distribution and having voltage ratings listed above, will be designed for successful operation when excited on full winding at 5% above their rated voltage

Transformers having voltage ratings of 6600/11430Y to 2300, are when operated in bank, suitable for transforming from 6600 to 2300; from 6600 to 4000Y or from 11430Y to 2300. They should not be used connected in "Y" on both high and low voltage sides simultaneously to transform from 11430Y to 4000Y as this connection may result in excessive stress in the windings due to harmonic voltages.

NOTE.—Voltage ratings in bold type will be considered the normal voltage ratings of these lines and guarantees will be made only on these normal voltage ratings. It is understood, however, that where a transformer is suitable for operation at two voltage ratings or at three voltage ratings, this flexibility will be definitely indicated on the name plate, on the connection diagram or on a paster inside the transformer cover.

Standard transformers having voltage ratings listed above will be designed for full rated kv-a. output at any specified tap voltage (not exceeding 10 per cent range) without exceeding guaranteed temperature rise.

TABLE I

(Adopted Standard May 5, 1920, to take effect January 1, 1921.)

Reference Number (9079)

STANDARD ACCESSORIES for SINGLE-PHASE DISTRIBUTION TRANSFORMERS of STANDARDIZED RATINGS

STANDARD KV-A. SIZES IN THE VARIOUS VOLTAGE CLASSES WITH WHICH ACCESSORIES WILL BE REGULARLY FURNISHED

Voltage Class	Plain Indicating Thermometer		Oil Gauge		Oil Drain Valve		Oil Drain Plug		Oil Sampling Valve		Provision for Filter Press Connection		Hanger Irons		Cutouts	
	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle	60 Cycle	25 Cycle
440		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller	10 and smaller	10 and smaller
550		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller	15 and smaller	15 and smaller
2300		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller	50 and smaller	50 and smaller
4600		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller	No cutouts are regularly furnished with transformers in the 4600 and higher voltage classes	
6600	No thermometers regularly furnished with 60-cycle transformers sizes 200 kv-a. and smaller	150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller		
11000		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller		
13200		150 and 200	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	100 and smaller	50 and smaller	150 and 200	75 to 200 incl.	150 and 200	75 to 200 incl.	50 and smaller	25 and smaller		
22000		150 and 200	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	37.5 and smaller	15 and smaller	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	No hanger irons are regularly furnished with transformers in the 22,000 and higher voltage classes			
33000		150 and 200	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	37.5 and smaller	15 and smaller	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.				
44000		150 and 200	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	37.5 and smaller	15 and smaller	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.				
66000		150 and 200	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.	37.5 and smaller	15 and smaller	50 to 200 incl.	25 to 200 incl.	50 to 200 incl.	25 to 200 incl.				

With a TRANSFORMER of SPECIAL RATING such accessories will be regularly furnished as would be supplied with a transformer of standard rating using the same mechanical parts.

(Adopted Standard May 5, 1920, to take effect January 1, 1921.)

TABLE III

THREE PHASE DISTRIBUTION TRANSFORMERS
SIZES 200 KV-A. AND BELOW
FOR SUPPLYING LIGHTING AND POWER SERVICE
STANDARD TYPES, FREQUENCIES, SIZES AND VOLTAGE RATINGS

STANDARD TYPES
Oil Immersed—Self Cooled

STANDARD FREQUENCIES
25 Cycles per Second
60 Cycles per Second

STANDARD SIZES IN KV-A. CONTINUOUS RATINGS AT 55 DEG. C. RISE

5–7.5–10–15–25–37.5–50–75–100–150–200

NOTE.—See following Table for sizes that are standard for the various system voltages.

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF TRANSFORMERS FOR THE VARIOUS SYSTEM VOLTAGES

Standard System Voltages	Standard Sizes for Each Voltage Class	For Supplying Service Voltages 600 and Below		
		Transformer High Voltage Ratings for Operation from Various Standard System Voltages		Transformer Low Voltage Ratings for Supplying Service Voltages 600 and Below
		On Full Winding	Approximately on 10% Tap	
2300	5 to 200 incl.	2200/3810Y		to 220/440
		2300/4000Y		to **230/460**
		2400/4150Y		to 240/480
4600	5 to 200 incl.	4400Y		to 220/440
		4600Y		to **230/460**
		4800Y		to 240/480
6600	10 to 200 incl.	6600Y	5940	to 220/440
		6900Y	6210	to **230/460**
		7200Y	6480	to 240/480
11000	10 to 200 incl.	11000Y	9900	to 220/440
		11500Y	10350	to **230/460**
13200	10 to 200 incl.	13200Y	11880	to 220/440
		13800Y	12420	to **230/460**
22000	15 to 200 incl.	22000Y	19800	to 220/440
		23000Y	20700	to **230/460**
33000	37.5 to 200 incl.	33000Y	29700	to 220/440
		34500Y	31050	to **230/460**

NOTE.—All sizes of distribution transformers having low voltage ratings of 230/460 are suitable for series or multiple three-phase service only by proper connection inside of the tank.

NOTE.—Voltage ratings in bold type will be considered the normal voltage ratings of these lines and guarantees will be made only on these normal voltage ratings. It is understood, however, that where a transformer is suitable for operation at two voltage ratings or at three voltage ratings, this flexibility will be definitely indicated on the name plate, on the connection diagram or on a paster inside the transformer cover.

Standard transformers having voltage ratings listed above will be designed for full rated kv-a output at any specified tap voltage without exceeding guaranteed temperature rise.

In general standard three-phase distribution transformers are not suitable for multiple operation with a bank of standard single-phase distribution transformers as the angular displacement, turn ratio and impedance volts on which successful multiple operation depends are generally different on three-phase and single-phase transformers.

TABLE II (Adopted Standard May 5, 1920, to take effect January 1, 1921.)

Reference Number

(9100)

RESERVED FOR RULES APPLICABLE ONLY TO GENERATING STATION TRANSFORMERS

Reference Number

RULES APPLICABLE ONLY TO POWER TRANSFORMERS FOR LIGHTING AND POWER SERVICE.

(Do not include those for special service, e.g., transformers for synchronous converters, electric furnaces, etc.)

(9201) **Classification.**

1. Power transformers shall be subdivided into "Generating Station Transformers" and "Substation Transformers." Generating station transformers shall include transformers in sizes above 200 KVA used as step up units in generating stations. Substation transformers shall include primarily those transformers in sizes above 200 KVA which are used to step down from a transmission voltage to a distribution voltage, and shall also include transformers in sizes above 200 KVA used to step down from either a transmission or distribution voltage to a standard service voltage.

(Adopted Standard 11-11-1917.)

(9215) **Rating Standards.**

1. Tables Nos. 4 and 5, respectively (see pages 170 and 171), summarize the standard types, frequencies and KVA sizes for single and three phase power transformers; also the standard voltage ratings and taps for single and three phase substation transformers for supplying lighting and power service.

(Adopted Standard 5-23-1919.)

(9216) **Basis of Rating.**

1. In the case of standard transformers having single voltage rating and provided with taps, the maximum rated voltage shall always be considered the normal voltage rating. In the case of standard transformers having a double voltage rating, the voltage appearing in bold type shall be considered the normal voltage rating. Performance guarantees of such transformers shall be based on the normal voltage rating and full winding. (Exception: See Temperature Rise Ref. 9231.)

(Adopted Standard 11-11-1917.)

Reference Number

2. The rated capacity of a transformer shall be the continuous output in KVA that it will carry without exceeding a temperature rise of 55° C.
(Adopted Standard 11-11-1917.)

(9217) **Voltage Ratings.**

1. No definite standard transformer voltage ratings have yet been established for operation from standard system voltages of 44,000, 66,000, 88,000, 110,000, etc. (Adopted Standard 11-11-1917.)

2. Multiple connections of the high voltage winding shall be omitted in standard transformers of the 6900-volt class or for higher voltages since taps are provided in the high voltage winding of such transformers. (Adopted Standard 11-11-1917.)

3. Series multiple connections of more than one combination, or of ratios other than 2:1, such as 110/220/440, 460/2300, 440/550/2200, are particularly undesirable from the standpoint of best transformer design and construction.
(Adopted Standard 11-11-1917.)

(9223) **Voltage Taps.**

1. Standard single phase substation transformers shall be provided with taps in the high voltage winding for 10% voltage variation in steps of approximately 2½%; and standard three phase substation transformers shall be provided with taps in the high voltage winding for 10% voltage variation in steps of approximately 5%.
(Adopted Standard 5-23-1919.)

2. Inasmuch as taps in three phase transformers multiply complications by three, as compared with single phase transformers, taps should be avoided where possible. (Adopted Standard 11-11-1917.)

(9231) **Temperature Rise.**

1. The standard temperature rise at continuous rated KVA output shall be 55° C. This temperature rise guarantee shall apply irrespective of whether transformer is operated on full winding or on any tap of 10% or less range.
(Adopted Standard 11-11-1917.)

Reference Number

2. Temperature rise of transformer windings shall be determined by the resistance method (A. I. E. E. Section 348).
(Adopted Standard 11-11-1917.)

3. Method of Loading (A. I. E. E. Sections 393 to 397, inclusive). (Adopted Standard 11-11-1917.)

4. Temperature Co-Efficient of Copper (A. I. E. E. Section 349). (Adopted Standard 11-11-1917.)

5. Temperature of Oil (A. I. E. E. Section 385). (Adopted Standard 11-11-1917.)

6. The temperature rise of water cooled transformers shall be figured above the inlet water temperature. When the inlet water temperature varies appreciably from the air temperature, A. I. E. E. Section 310 shall apply.
(Adopted Standard 11-11-1917.)

7. If at the time of making temperature test of an air blast transformer, the ambient temperature varies from 40° C., a correction factor as provided for in A. I. E. E. Section 321 shall be applied.
(Adopted Standard 11-11-1917.)

8. In measuring transformer temperatures observed results shall include correction for falling temperature between the instant of shutdown and the instant of measurement (A. I. E. E. Section 348).

For power transformers—sizes above 200 KVA the following practice is accepted:

(a) *Oil Immersed Transformers*: For the purpose of simplifying the application of the rule to transformers when:

(1) The weight of copper in each winding is known:

(2) The copper loss as determined by wattmeter measurement does not exceed 30 watts per lb.,
the extrapolation method has been reduced to the following form and is recommended on account of the greater accuracy obtainable under ordinary conditions of testing. The correction in degrees C. shall be the product of the watts loss per lb. of copper for each winding multiplied by a factor depending upon the time elapsed between shutdown

Reference Number

and the time of the temperature reading as given in the following table:

Time in Minutes.	Factor.
1	.19
2	.32
3	.43
4	.50

For intermediate times, the value of the factor can be obtained by interpolation.

Exception: When the copper loss, measured by wattmeter, does not exceed 7 watts per lb. an arbitrary correction of one degree per minute may be used provided the time elapsed between the instant of shutdown and the measurement of the hot resistance does not exceed 4 minutes.

For determining the copper loss in watts per lb. the total loss in both windings as measured by wattmeter should be apportioned between the high and low voltage windings in the same ratio as their respective I^2R losses.

(b) *Air Blast Transformers*: An arbitrary correction of one degree per minute may be used provided the time elapsed between the instant of shutdown and the measurement of the hot resistance does not exceed 4 minutes.

In measuring the temperature of air blast transformers, the air supply shall be shut off immediately at the end of the temperature run and the air intake closed to prevent further admission of cooling air. In checking the temperatures ascertained by the resistance method, the readings of thermometers well distributed and in good contact with the coils shall be noted and the maximum temperature indicated by them if higher than that determined by the resistance method, shall be taken as the maximum observable temperature of the windings. When the above procedure has been followed, a hottest spot correction of 5 degrees shall be applied.

(Adopted Standard 5-23-1919.)

(9235) **Regulation**

1. The guarantee as to regulation shall be based on a reference temperature of 75° C.

(Adopted Standard 11-11-1917.)

Reference Number

2. The test as to the fulfillment of the regulation guarantee shall be made at any convenient temperature and corrected to a reference temperature of 75° C. (Adopted Standard 11-11-1917.)

3. Tests and computation of regulation for constant potential transformers for any specific load and power factor shall be computed from the measured impedance watts and impedance volts as follows:

Let: P=Impedance watts, as measured in the short circuit test. (See Ref. 9248.)

E_z=Impedance volts as measured in the short circuit test. (See Ref. 9248.)

IX=Resistance drop in volts.

I=Rated primary current.

E=Rated primary voltage.

q_x=Per cent drop in quadrature with current.

q_r=Per cent drop in phase with current.

$$IX=\sqrt{E_z^2 \quad \left(\frac{P}{I}\right)^2}$$

$$q_r=100\frac{P}{EI}$$

$$q_x=100\frac{IX}{E}$$

Then A. For unity power factor we have approximately:

$$\text{Per cent regulation} = q_r + \frac{q_x^2}{200}$$

B. For inductive loads of power factor m and reactive factor n:

$$\text{Per cent regulation}=mq_r + nq_x + \frac{(mq_x-nq_r)^2}{200}$$

(Adopted Standard 11-11-1917.)

Reference Number

(9240) **Dielectric Tests.**

1. The standard values for insulation test voltages for power transformers shall be as follows:

High Voltage Winding to Low Voltage Winding and Core.

Highest Operating Voltage.	Test Voltage.
Below 550 volts	4,000 volts
550 to 4,500 volts, inclusive	10,000 volts
Above 4,500 volts	Twice the highest operating voltage plus 1,000 volts.

Low Voltage Winding to Core.

Highest Operating Voltage.	Test Voltage.
1,500 volts and below	4,000 volts
Above 1,500 to 4,500 volts, inclusive	10,000 volts
Above 4,500 volts	Twice the highest operating voltage of the Low Voltage Winding plus 1,000 volts.

(Adopted Standard 1-13-1919.)

2. Transformers intended for Y connection shall have their test voltages determined by the line voltage and not the leg voltage.
(Adopted Standard 11-11-1917.)

3. Dielectric tests shall be made as outlined below:

a. Between high voltage and low voltage windings.

b. Between high voltage winding and the core. [(a) and (b) may be made at the same time by connecting the low voltage winding to the core.]

c. Between the low voltage winding and the core. (Adopted Standard 11-11-1917.)

4. The time of application for each test as outlined in preceding paragraphs of this section, shall be one minute. (Adopted Standard 5-30-1918.)

5. Measurement of voltage in making dielectric tests shall be in accordance with A. I. E. E. Sections 530 to 541, inclusive.
(Adopted Standard 11-11-1917.)

Reference Number

(9248) **Losses and Efficiency.**

1. Guarantees as to losses shall be based upon a reference temeprature of 75° C.
(Adopted Standard 11-11-1917.)

2. All losses shall be guaranteed on the basis of measurement with a true sine wave.
(Adopted Standard 11-11-1917.)

3. If the wave form of the circuit employed for test differs from the sine wave, reference to A. I. E. E. Section 406 shall be made to determine whether such variation exceeds that permissible.
(Adopted Standard 11-11-1917.)

4. Transformer losses shall be considered under two divisions: No load losses and load losses.
(Adopted Standard 11-11-1917.)

5. No load losses shall be the losses measured by wattmeter when normal rated voltage at rated frequency is applied to either winding, the other winding being open circuited. Since there is no appreciable variation of no load losses due to temperature changes, within the limits of operating temperatures, the test may be made at any convenient temperature without the necessity for correction by referring measured values to the standard reference temperature of 75° C. (A. I. E. E. Section 445). (Adopted Standard 11-11-1917.)

6. Load losses shall be the losses measured by wattmeter when adequate voltage is applied to the primary winding to produce rated current in the secondary winding, the latter being short circuited. (Either the high voltage or the low voltage winding may be used as the primary.) Tests may be made at any convenient temperature and corrected to the standard reference temperature of 75° C. (A. I. E. E. Section 445).
(Adopted Standard 11-11-1917.)

7. Tolerance Factors—

No load losses 10%
Load losses 5%
(Adopted Standard 11-11-1917.)

Reference Number

8. On orders covering three or less units the above tolerances shall apply to each unit, but if an order covers more than three units, the tolerance shall apply to the individual units only. The obligation in the latter case shall be that the average losses of all the units on a particular order shall represent guaranteed values, and that no tolerance factors shall be applied to this average.

(Adopted Standard 11-11-1917.)

9. Efficiency=[KVA Output (100% power factor)]÷[KVA Output (100% factor)+Total losses at 75° C.]

Total losses shall be obtained as outlined in preceding paragraphs of this section.

(Adopted Standard 11-11-1917.)

(9276) **Terminal Markings.**

1. For method of marking transformer terminals see General Engineering Recommendations Ref. 5404. (Adopted Standard 5-30-1918.)

(9277) **Transformer Polarity.**

Subtractive Polarity will be standard for all single phase transformers in sizes above 200 KVA, irrespective of voltage rating.

(Adopted Standard 5-5-1920, to take effect January 1, 1921.)

(9279) **Transformer Accessories.**

Standard accessories for single phase power transformers, sizes above 200 KVA, will be as follows:

Oil gauge, oil drain valve, oil sampling valve and provision for filter press connection, will be reguarly furnished with all single phase outdoor transformers in sizes above 200 KVA.

Plain standard indicating thermometers will be regularly furnished with all single phase power transformers in sizes above 200 KVA, except that indicating thermometers with alarm contact will be furnished with self-cooled transformers 1000 KVA and larger, also with all water-cooled transformers, irrespective of size.

(Adopted Standard 5-5-1920, to take effect January 1, 1921.)

Reference Number (9215)

TRANSFORMI
THREE PHASE POW
SIZES ABO
FOR SUPPLYING LIGHTI
STANDARD TYPES, FREQUENCIE

STANDARD TYPES

Oil Immersed—Self Cooled
Oil Immersed—Water Cooled
Air Blast

NOTE.—The application of Air Blast Transformers should be confined to systems where the voltage does not exceed 25,000.

STANDARD SIZES IN KV-A. CONTIN

Oil Immersed—Self Cooled

300	1200	3750	15000
450	1500	5000	20000
600	2000	6000	25000
750	2500	7500	30000
1000	3000	10000	

NOTE.—See following Table for sizes that are standard for t

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF SUBSTA

For Supplying Service Voltages 600 and below

Standard System Voltages	Standard Sizes for Each Voltage Class	Transformer High Voltage Ratings for Operation from Various Standard System Voltages			Transformer Low Voltag Supplying Service Voltages
	Oil Immersed Self Cooled	On Full Winding	Approximately on Taps 5%	Approximately on Taps 10%	
2300	300 to 1500 incl.	2200/3810Y **2300/4000Y**	2090/3615Y 2185/3785Y	1980/3430Y 2070/3585Y	.....to 220/440 ...or 1 .....to **230/460** ...or 1
4600	300 to 1500 incl.	2200Y 4400Y **2300Y** **4600Y**	2090 4180 2185 4370	1980 3960 2070 4140	.....to 220/440 ...or 1 .....to **230/460** ...or 1
6600	300 to 1500 incl.	6600Y **6900Y**	6270 6555	5940 6210	.....to 220/440 ...or 1 .....to **230/460** ...or 1
11000	300 to 1500 incl.	11000Y **11500Y**	10450 10925	9900 10350	.....to 220/440 ...or 1 .....to **230/460** ...or 1
13200	300 to 1500 incl.	13200Y **13800Y**	12540 13110	11880 12420	.....to 220/440 ...or 1 .....to **230/460** ...or 1
22000	300 to 1500 incl.	22000Y **23000Y**	20900 21850	19800 20700	.....to 220/440 ...or 1 .....to **230/460** ...or 1
33000	300 to 1500 incl.	33000Y **34500Y**	31350 32775	29700 31050	.....to 220/440 ...or 1 .....to **230/460** ...or

NOTE.—Transformers having low voltage rating of 230/460 are suit multiple service only.

NOTE.—Voltage ratings in bold type will be considered the normal voltage ratings of these lines and transformer is suitable for operation at two voltage ratings this flexibility will be definitely in

Standard transformers having voltage ratings listed above will be designed for full rated kv

TA

Reference Number (9215)

TRANSFORMERS—Continued

SINGLE PHASE POWER TRANSFORMERS

SIZES ABOVE 200 KV-A.

FOR SUPPLYING LIGHTING AND POWER SERVICE

STANDARD TYPES, FREQUENCIES, SIZES AND VOLTAGE RATINGS

STANDARD TYPES

Oil Immersed—Self Cooled
Oil Immersed—Water Cooled
Air Blast

STANDARD SIZES IN KV-A. CONTINUOUS RATINGS AT 55 DEG. C. RISE

Oil Immersed—Self Cooled				Oil Immersed—Water Cooled or Air Blast			
250	667	1667	5000	500	1250	3333	10000
333	833	2000	6667	667	1667	5000	
400	1000	2500	8333	833	2000	6667	
500	1250	3333	10000	1000	2500	8333	

STANDARD FREQUENCIES

25 Cycles per Second
60 Cycles per Second

NOTE.—The application of Air Blast Transformers should be confined to systems where the voltage does not exceed 25,000

NOTE.—See following table for sizes that are standard for the various system voltages.

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF SUBSTATION TRANSFORMERS FOR THE VARIOUS SYSTEM VOLTAGES

Standard System Voltages	Standard Sizes for Each Voltage Class	For Supplying Service Voltages 600 and below: Transformer High Voltage Ratings for Operation from Various Standard System Voltages					Transformer Low Voltage Ratings for Supplying Service Voltages 600 and Below	For Supplying Distribution Voltages Above 600: Standard Sizes for Each Voltage Class		Transformer High Voltage Ratings for Operation from Various Standard System Voltages					Transformer Low Voltage Ratings for Supplying Nominal 2300 or 4000-volt Distribution
	Oil Immersed Self Cooled	On Full Winding	Approximately on Taps 2½%	5%	7½%	10%		Oil Immersed Self Cooled	Oil Immersed Water Cooled or Air Blast	On Full Winding	Approximately on Taps 2½%	5%	7½%	10%	
2300	250 to 500 incl.	2200 **2300**	2145 2245	2090 2185	2035 2130	1980 2070	...to 220/110 (3-wire) ...or to 220/440 or to 550 ...to **230/115** (3-wire) ...or to **230/460 or to 575**								
4600	250 to 500 incl.	2200 4400 **4600**	4290 4485	2090 4180 2185 4370	4070 4255	1980 3960 2070 4140	...to 220/110 (3-wire) ...or to 220/440 or to 550 ...to **230/115** (3-wire) ...or to **230/460 or to 575**								
6600	250 to 500 incl.	6600 **6900**	6435 6730	6270 6555	6105 6385	5940 6210	.....to 220/440 or to 550 .....to **230/460 or to 575**	250 to 1000 incl.	500 to 2300 incl.	**6600**	6435	6270	6105	5940	...to **2300/4000Y**
11000	250 to 500 incl.	11000 **11500**	10725 11215	10450 10925	10175 10640	9900 10350	.....to 220/440 or to 550 .....to **230/460 or to 575**	230 to 2500 incl.	500 to 5000 incl.	**11000**	10725	10450	10175	9900	...to **2300/4000Y**
13200	250 to 500 incl.	13200 **13800**	12870 13455	12540 13110	12210 12765	11880 12420	.....to 220/440 or to 550 .....to **230/460 or to 575**	250 to 2500 incl.	500 to 5000 incl.	**13200**	12870	12540	12210	11880	...to **2300/4000Y**
22000	250 to 500 incl.	22000 **23000**	21450 22425	20900 21850	20350 21275	19800 20700	.....to 220/440 or to 550 .....to **230/460 or to 575**	230 to 2500 incl.	500 to 5000 incl.	**22000**	21450	20900	20350	19800	...to **2300/4000Y**
33000	250 to 500 incl.	33000 **34600**	32175 33640	31350 32775	30525 31915	29700 31050	.....to 220/440 or to 550 .....to **230/460 or to 575**	250 to 2500 incl.	500 to 5000 incl.	**33000**	32175	31350	30525	29700	...to **2300/4000Y**

NOTE.—Transformers having low voltage rating of 230/115 are arranged for series or three-wire service only. Transformers having low voltage rating of 230/460 are suitable for series or multiple service only.

NOTE.—Standard Single-phase Substation Transformers for supplying nominal 2300 or 4000-volt distribution and having voltage ratings listed above, will be designed for successful operation when excited on full winding at 5% above their rated voltage.

NOTE.—Voltage ratings in bold type will be considered the normal voltage ratings of these lines and guarantees will be made only on these normal voltage ratings. It is understood, however, that where a transformer is suitable for operation at two voltage ratings this flexibility will be definitely indicated on the name plate, on the connection diagram or on a paster inside the transformer cover.

Standard transformers having voltage ratings listed above will be designed for full rated kv-a. output at any specified tap voltage without exceeding guaranteed temperature rise.

TABLE IV

(Adopted Standard 5-30-1918.)

THREE PHASE POWER TRANSFORMERS

SIZES ABOVE 200 KV-A.

FOR SUPPLYING LIGHTING AND POWER SERVICE

STANDARD TYPES, FREQUENCIES, SIZES AND VOLTAGE RATINGS

STANDARD TYPES

Oil Immersed—Self Cooled
Oil Immersed—Water Cooled
Air Blast

STANDARD SIZES IN KV-A. CONTINUOUS RATINGS AT 55 DEG. C. RISE

Oil Immersed—Self Cooled

300	1200	3750	15000
450	1500	5000	20000
600	2000	6000	25000
750	2500	7500	30000
1000	3000	10000	

Oil Immersed—Water Cooled or Air Blast

750	2500	7500	30000
1000	3000	10000	
1200	3750	15000	
1500	5000	20000	
2000	6000	25000	

STANDARD FREQUENCIES

25 Cycles per Second

60 Cycles per Second

Note.—The application of Air Blast Transformers should be confined to systems where the voltage does not exceed 25,000.

Note.—See following Table for sizes that are standard for the various system voltages.

STANDARD SIZES, VOLTAGE RATINGS AND TAPS OF SUBSTATION TRANSFORMERS FOR THE VARIOUS SYSTEM VOLTAGES

Standard System Voltages	For Supplying Service Voltages 600 and below: Standard Sizes for Each Voltage Class — Oil Immersed Self Cooled	Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately on Taps 5%	Approximately on Taps 10%	Transformer Low Voltage Ratings for Supplying Service Voltages 600 and Below	For Supplying Distribution Voltages Above 600: Standard Sizes for Each Voltage Class — Oil Immersed Self Cooled	Oil Immersed Water Cooled or Air Blast	Transformer High Voltage Ratings for Operation from Various Standard System Voltages — On Full Winding	Approximately on Taps 5%	Approximately on Taps 10%	Transformer Low Voltage Ratings for Supplying Nominal 2300-volt Distribution
2300	300 to 1500 incl.	2200/3810Y **2300 4000Y**	2090/3615Y 2185/3785Y	1980/3430Y 2070/3585Y	.....to 220/440 ...or to 550 .....to **230/460** ...or to **575**						
4600	300 to 1500 incl.	2200Y 4400Y **2300Y** **4600Y**	2090 4180 2185 4370	1980 3960 2070 4140	.....to 220/410 .. or to 550 .....to **230/460** ...or to **575**						
6600	300 to 1500 incl.	6600Y **6900Y**	6270 6555	5940 6210	.....to 220/440 ...or to 550 .....to **230/460** ...or to **575**	300 to 3000 incl.	750 to 7500 incl.	**6600Y**	6270	5940	.....to **2300**
11000	300 to 1500 incl.	11000Y **11500Y**	10450 10925	9900 10350	.....to 220/440 ...or to 550 .....to **230/460** ...or to **575**	300 to 7500 incl.	750 to 15000 incl.	**11000Y**	10450	9900	.....to **2300**
13200	300 to 1500 incl.	13200Y **13800Y**	12540 13110	11880 12420	.....to 220/440 ...or to 550 .....to **230/460** ...or to **575**	300 to 7500 incl.	750 to 15000 incl.	**13200Y**	12540	11880	.....to **2300**
22000	300 to 1500 incl.	22000Y **23000Y**	20900 21850	19800 20700	.....to 220/440 ...or to 550 .....to **230/460** ...or to **575**	300 to 7500 incl.	750 to 15000 incl.	**22000Y**	20900	19800	.....to **2300**
33000	300 to 1500 incl.	33000Y **34500Y**	31350 32775	29700 31050	.....to 220/440 ...or to 550 .....to **230/460** ...or to **575**	300 to 7500 incl.	750 to 15000 incl.	**33000Y**	31350	29700	.....to **2300**

Note.—Transformers having low voltage rating of 230/460 are suitable for series or multiple service only.

Note.—Standard Three-phase Substation Transformers for supplying nominal 2300-volt distribution and having voltage ratings listed above, will be designed for successful operation when excited on full winding at 5% above their rated voltage.

Standard Three-phase Substation Transformers having voltage ratings listed above are not suitable for supplying 4000-volt distribution as such service would necessitate "Y" connection on both high and low voltage sides simultaneously and this connection may result in excessive stress in the windings due to harmonic voltages.

Note.—Voltage ratings in bold type will be considered the normal voltage ratings of these lines and guarantees will be made only on these normal voltage ratings. It is understood, however, that where a transformer is suitable for operation at two voltage ratings this flexibility will be definitely indicated on the name plate, on the connection diagram or on a paster inside the transformer cover.

Standard transformers having voltage ratings listed above will be designed for full rated kv-a. output at any specified tap voltage without exceeding guaranteed temperature rise.

TABLE V

(Adopted Standard 5-23-1919.)

ER TRANSFORMERS

E 200 KV-A.
NG AND POWER SERVICE
S, SIZES AND VOLTAGE RATINGS

UOUS RATINGS AT 55 DEG. C. RISE

Oil Immersed—Water Cooled or Air Blast

750	2500	7500	30000
1000	3000	10000	
1200	3750	15000	
1500	5000	20000	
2000	6000	25000	

STANDARD FREQUENCIES

25 Cycles per Second

60 Cycles per Second

he various system voltages.

TION TRANSFORMERS FOR THE VARIOUS SYSTEM VOLTAGES

e Ratings for 600 and Below	For Supplying Distribution Voltages Above 600					
	Standard Sizes for Each Voltage Class		Transformer High Voltage Ratings for Operation from Various Standard System Voltages			Transformer Low Voltage Ratings for Supplying Nominal 2300-volt Distribution
	Oil Immersed Self Cooled	Oil Immersed Water Cooled or Air Blast	On Full Winding	Approximately on Taps 5%	Approximately on Taps 10%	
o 550 o **575**						
o 550 o **575**						
o 550 o **575**	300 to 3000 incl.	750 to 7500 incl.	**6600Y**	6270	5940	....to **2300**
o 550 o **575**	300 to 7500 incl.	750 to 15000 incl.	**11000Y**	10450	9900	....to **2300**
o 550 o **575**	300 to 7500 incl.	750 to 15000 incl.	**13200Y**	12540	11880	....to **2300**
o 550 o **575**	300 to 7500 incl.	750 to 15000 incl.	**22000Y**	20900	19800	....to **2300**
o 550 o **575**	300 to 7500 incl.	750 to 15000 incl.	**23000Y**	31350	29700	....to **2300**

able for series or

NOTE.—Standard Three-phase Substation Transformers for supplying nominal 2300-volt distribution and having voltage ratings listed above, will be designed for successful operation when excited on full winding at 5% above their rated voltage.

Standard Three-phase Substation Transformers having voltage ratings listed above are not suitable for supplying 4000-volt distribution as such service would necessitate "Y" connection on both high and low voltage sides simultaneously and this connection may result in excessive stress in the windings due to harmonic voltages.

guarantees will be made only on these normal voltage ratings. It is understood, however, that where a dicated on the name plate, on the connection diagram or on a paster inside the transformer cover.

-a. output at any specified tap voltage without exceeding guaranteed temperature rise.

BLE V

(Adopted Standard 5-23-1919.)

Reference Number

(9300) RESERVED FOR RULES APPLICABLE ONLY TO DISTRIBUTION AND SUBSTATION TRANSFORMERS FOR SPECIAL SERVICE, SUCH AS TRANSFORMERS FOR OPERATING SYNCHRONOUS CONVERTERS, ETC.

(9400) RESERVED FOR RULES APPLICABLE ONLY TO BELL RINGING AND TOY TRANSFORMERS.

(9500) RESERVED FOR RULES APPLICABLE ONLY TO BALANCING COILS AND STREET LIGHTING EQUIPMENTS.

POWER SWITCHBOARDS AND OIL CIRCUIT BREAKERS

Reference Number

(10100) **Rated Amperes.**

Oil circuit breakers shall be rated in R.M.S. amperes based on the permissible, observable temperature rise in accordance with Rule 721 Standardization Rules of the A. I. E. E.

(Adopted Standard 5-23-1919.)

(10102) **Ambient Temperature.**

Power Club Rules 1060 and 5002 shall be followed, except that for oil circuit breakers the ambient temperature shall be determined by taking the average of the readings of three thermometers placed as follows: One twelve inches above, one twelve inches below, and one midway but twelve inches from the breaker as installed.

(Adopted Standard 5-23-1919.)

(10103) **Rated Volts.**

Oil circuit breakers shall be rated in R.M.S. volts based on a dielectric test in accordance with Rule 722 Standardization Rules of the A. I. E. E.

(Adopted Standard 5-23-1919.)

(10104) **Rated Interrupting Capacity.**

Oil circuit breakers shall be rated in R.M.S. amperes interrupting capacity in accordance with Rule 720 Standardization Rules of the A. I. E. E. (Revision of 1918) as follows:

"By interrupting (breaking or rupturing) capacity is meant the highest R.M.S. current at normal voltage which the device can interrupt under prescribed conditions at stated intervals a specified number of times."

The "stated intervals" and "specified number of times" at a given current and voltage determine the duty imposed upon a breaker. The duty shall be assumed to be that the breaker will interrupt its rated R.M.S. current two times at a two-minute interval and then be in condition to be closed and carry its rated current until it is practical to inspect it and make necessary adjustments.

The "prescribed conditions" include the stored electro-static and magnetic energy of the system,

Reference Number

re-establishment of an arc under transient voltage conditions and other variable conditions. These influences are considered as not differing widely in average systems and are to be taken into account in the factor of safety employed in the rating of breakers.

In addition a momentary carrying capacity in R.M.S. amperes shall be given.

Note.—The National Electric Light Association, through its Subcommittee on Switchboards, is taking an active interest in this subject and proposes to submit data and suggestions to manufacturers for their guidance in determining modifications of and additions to the above interrupting capacity rule.

(Adopted Standard 5-23-1919.)

STANDARD AMPERE RATINGS.

(10120) **Frequency of Rating.**

Ratings not otherwise specified are understood to be at 60 cycles. At and above 600 amperes, both 25 cycles and 60 cycles may be given.

(Adopted Standard 5-23-1919.)

(10121) **Standard 60 Cycle Ratings.**

Existing oil circuit breakers, so far as possible, and all new designs of oil circuit breakers (other than industrial type) shall have ampere ratings at 60 cycles as follows:

200	1600
400	2000
600	2400
800	3000
1200	4000

(Adopted Standard 5-23-1919.)

(10122) **Standard 25 Cycle Ratings.**

Oil circuit breakers for 25 cycle service shall be standard 60 cycle breakers given their corresponding rating at 25 cycles.

(Adopted Standard 5-23-1919.)

Reference Number

STANDARD INTERRUPTING CAPACITY RATINGS.

(10140) **Published Ratings.**

Published ampere interrupting capacity ratings shall be at standard voltages stated in Rule 130 and, in addition, at the following intermediate voltages:

6000 12000 30000

Interrupting capacities at intermediate voltages are obtained by inverse proportion related to the next higher listed voltage.

(Adopted Standard 5-23-1919.)

LIMITATIONS OF APPLICATION.

(10150) **Panel and Panel Frame Mounting.**

(a) Panel mounting oil circuit breakers shall be limited to 800 amperes maximum rating, and panel frame mounting oil circuit breakers shall be limited to 2000 amperes maximum rating.

(b) Panel and panel frame mounting oil circuit breakers shall be limited to 2500 volts maximum rating. (Adopted Standard 5-23-1919.)

(10151) **Series Trip Coils in Panel or Panel Frame Mounting Oil Circuit Breakers.**

Series trip coils in panel or panel frame mounting oil circuit breakers shall be limited as follows:

(a) Maximum current rating, 200 amperes.

(b) Maximum voltage rating of coils, 750 volts.

(Adopted Standard 5-23-1919.)

RECOGNIZED DEPARTURES

FROM THE STANDARDS OF THE ELECTRIC POWER CLUB.

Reference Number

It is recognized by members of The Electric Power Club that the advance of the industry, the progressive development of the art of manufacturing electrical apparatus, and the rewards to which individual members are properly entitled as the result of initiative, research and invention, must not be retarded or curtailed by adopted standards to which the majority still subscribe; that during a period of change or progressive development honest differences of opinion may arise over a proposed change or departure from an existing standard; and that where there is reasonable evidence that such change is in the public interest, it is desirable that, while its merits are being generally demonstrated, the departure be formally recognized by The Electric Power Club as the authoritative body controlling the standardization of Electrical Apparatus.

In accordance with the above paragraph the following departures from standard practices and recommendations of The Electric Power Club have been formally recognized by The Electric Power Club:

1. 50° open type continuous duty motors for general purposes. (Recognized 5-23-1919.)

2. 50° direct current generators

For standard temperature ratings of The Electric Power Club see No. 5303.

(Recognized 5-23-1919.)

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ADDENDA

THE FOLLOWING SHEETS CONTAIN CERTAIN INFORMATION RELATIVE TO MEMBER COMPANIES OF THE ELECTRIC POWER CLUB. ONE PAGE ONLY IS ALLOTTED TO EACH. THE INFORMATION GIVEN IS AS FOLLOWS:

NAME AND ADDRESS,

OFFICERS,

APPARATUS MANUFACTURED,

BRANCH OFFICES.

Insertion is alphabetical.

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Trade Names: "AB," "Adams-Bagnall," "Gyrofan," "Abolites."

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Electric Air Compressors
Portable Electric Drills
Electric Valve Grinders

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ATLANTA.....314-315 Chamber of Commerce
SAN FRANCISCO.....918 Hearst Bldg.
LOS ANGELES.....310 Hibernian Bank Bldg.
SEATTLE.....201 Maynard Bldg.
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CLEVELAND.....6523 Euclid Ave.
BUFFALO.....198 Hutchinson Ave.

LONDON.....Mr. R. A. Rothermel, 2426 Maddox St., Regent St., London, W. 1.
PARIS.....American Trading Co., 64 Rue de la Chausee d'Antin, Paris, France.
BRUSSELS.....American Trading Co., 148 Rue Nueve, Brussels, Belgium.

Bodine Electric Company

MAIN OFFICE AND FACTORY
OHIO AND OAKLEY BOULEVARD

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E. C. BODINE . . . VICE-PRESIDENT
P. J. BODINE . . . SECRETARY AND TREASURER

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Direct Current Motors 1-100 to 1-4 H.P.
Alternating Current Motors 1-100 to 1-4 H.P.
Electric Bench Grinders
Dynamotors, Motor-Generators and Cautery Generators for Physicians
Jewelers' and Dental Motors
Rotary Converters
Centrifuges

AGENCIES IN PRINCIPAL CITIES

Burke Electric Company

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DIRECT CURRENT	ALTERNATING CURRENT
Engine Type Generators	*Engine Type Alternators*
3 Wire Eng. Type "	*Belted Type "*
Belted Type "	*Coupled Type "*
3 Wire Belt Type "	*Synchronous Motors*
Coupled Type "	*Induction Motors*
Motors	*Adjustable Varying Speed Ind. Motors*
Adjustable Speed Motors	*Synchronous Ind. Motors*
Crane Motors	*Crane Motors*
Elevator Motors	*Elevator Motors*
Small D. C. Motors	*Transformers*
	Small A. C. Motors

Universal Motors for operating on both A.C. and D.C.
Burke Electric Company Speed Change System
Electric Arc Welding Equipments
A. C. and D. C. Mill Motors ***Motor Generator Sets***

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BUFFALO.....510 Morgan Building
DETROIT.....1904 Dime Bank Building

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Main Office and Works

19th, Pine to Olive Streets

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J. L. WOODRESS..Sales Manager and Assistant Secretary
JOHN HERGET .....Treasurer
B. M. WHITTEMORE.....Assistant Treasurer

APPARATUS MANUFACTURED

Century — *Single Phase Alternating Current Motors*

Century — *Polyphase Alternating Current Motors*

"Invincible" — *Split Phase Alternating Current Motors*

Century — *Fan Motors Alternating Current*

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CHATTANOOGA
CHICAGO
CINCINNATI
CLEVELAND
DALLAS
DENVER
DES MOINES
DETROIT
GREENSBORO
KANSAS CITY
LITTLE ROCK
LOS ANGELES
MINNEAPOLIS
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURG
PORTLAND
ROCHESTER
SALT LAKE CITY
SAN FRANCISCO
SEATTLE
SPOKANE

Montreal, Toronto, Vancouver, Winnipeg, Canada.

Chandeysson Electric Company

ST. LOUIS, U. S. A.

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W. C. FORDER.....Treasurer
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APPARATUS MANUFACTURED:

Chandeysson "Special" Direct to Shaft Connected Sewing Machine Motors.
Direct Current Motors, Constant Speed.
Direct Current Generators.
Direct Current Motors, Adjustable Speed.
Motor Generator Sets.
Electrolytic Dynamos.

Chicago Pneumatic Tool Company

6 E. 44th St., New York City.

APPARATUS MANUFACTURED

Little Giant Portable Electric Drills and Grinders; Little Giant Electric Hammer Drills; Boyer Pneumatic Riveting and Chipping Hammers; Portable Pneumatic Hoists; Little Giant Air Drills and Grinders; "Chicago Pneumatic" Air Compressors and Vacuum Pumps; Giant Fuel Oil, Gas, Gasoline and Steam Engines; Rock Drills; Coal Drills.

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Cincinnati, Ohio.
Cleveland, Ohio.
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Eldorado, Kan.
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Los Angeles, Cal.
Milwaukee, Wis.
Minneapolis, Minn.
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Philadelphia, Pa.
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Depend Upon That Name

The Cincinnati Electrical Tool Co.

CINCINNATI, OHIO.

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JOSEPH WOLF .....Vice-President
J. ALBERT GOLDMAN.....Treasurer
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APPARATUS MANUFACTURED

Portable Electrical Drills

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Jas. Clark, Jr., Electric Co., Inc.

520 MAIN STREET

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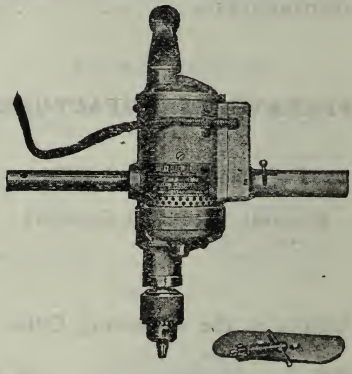
C. E. WILLEY . .	VICE-PRESIDENT AND SUPT.

APPARATUS MANUFACTURED

Portable Drills,	*A.C. & D.C*
Center Grinders,	" "
Buffers and Bench Grinders,	" "



Floor Grinders,	*A.C. & D.C.*
Sensitive Drills,	" "
Locomotive Turntable Motors,	" "
Alternating and Direct Current Motors,	
Alternating and Direct Current Dynamos.	

All tools electrically driven

Electrical Manufacturing Co.

Main Office and Factory

SOUTH BOSTON, MASS.

MANUFACTURERS OF

Air Circuit Breakers
Oil Motor Starters
Oil Switches and Circuit Breakers
Relays
Switchboards
Transformers

BRANCH OFFICES

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Detroit, Mich.
Jacksonville, Fla.
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Crocker-Wheeler Company

Main Office and Works

AMPERE, NEW JERSEY, U. S. A.

APPARATUS MANUFACTURED:

ALTERNATING CURRENT APPARATUS:

Generators for Engine Drive; Generators for Belt Drive; Generators for Three-Wire Systems; Polyphase Induction Motors; Single Phase Induction Motors (fractional horsepower sizes); Synchronous Motor-Generator Sets; Induction Motor-Generator Sets.

DIRECT CURRENT APPARATUS:

Generators for Engine Drive; Generators for Belt Drive; Generatory for Three-Wire Systems; Motors for Belt, Coupled or Geared Drive; Mill Motors for Heavy Duty, Intermittent Service; Motor-Generator Sets.

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PITTSBURG
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The Cutler-Hammer Mfg. Co.

MILWAUKEE, WIS.

APPARATUS MANUFACTURED

Motor Starting and Controlling Apparatus for D. C. and A. C. Motors
Dynamo Field Rheostats
Theater Dimmers
Float Switches
Pressure and Vacuum Regulators
Machine Tool Controllers
Magnetic Switches
Lifting Magnets
Magnetic Clutch-Brakes
Lamp Sockets, Switches, Attachment Plugs and other wiring devices
Printing Press Controllers and Equipment
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CINCINNATI . .	Gwynne Building
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APPARATUS MANUFACTURED

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Interchangeable Direct and Alternating Current Fractional Horse Power Motors.

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The Domestic Electric Company

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MANUFACTURERS OF

Fractional Horse-Power Motors

Domestic Electric
TRADE MARK REG.
Motors

Duncan Electric Manufacturing Co.

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For Direct Currents:

House Type Watthour Meters
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Switchboard Watthour Meters
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Eck Dynamo & Motor Company

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Direct Current Motors of all types, 1-32 to 40 H.P.
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Dynamotors
Rotary Converters
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Direct and Alternating Current Fans, Desk and Oscillating type
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Factory and Main Office: Orange, N. J.

MANUFACTURERS OF

EDISON STORAGE BATTERIES

for

Industrial Trucks and Tractors, Lumber Carriers, Industrial and Mine Locomotives, Electric Commercial Street Trucks, Edison Electric Safety Mine Lamps, Meter Testing, Time Clock and Fire Alarm Systems, House Lighting Plants, Emergency Power for Lighting and Wireless on Shipboard, etc.

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Cleveland	Detroit	Chicago	Seattle
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The Electric Controller & Mfg. Co.

CLEVELAND, OHIO

APPARATUS MANUFACTURED

Controllers for Electric Motors
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TORONTO	Traders Bank Building

Electric Machinery Company

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APPARATUS MANUFACTURED

Alternators and Synchronous Motors, All Types—
Engine, Coupled, Belted, Vertical.
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APPARATUS MANUFACTURED

Motor-Generators for Battery Charging.
Rheostats for Battery Charging.
Direct Current Vehicle Motors.
D. C. and A. C. Power Switchboards.
Grid Resistors.

BRANCH OFFICES

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Electro-Dynamic Company

BAYONNE, N. J.

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HENRY R. SUTPHEN . . . . . Vice-President

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ALTERNATING CURRENT	DIRECT CURRENT.
Squirrel Cage Induction Motors	Interpole Motors.
High Torque Squirrel Cage Induction Motors.	Interpole Generators.
Constant Speed Slip Ring Induction Motors.	Motor Generator Sets.
Variable Speed Slip Ring Induction Motors.	Constant Speed Motors.
Motors for Cranes and Hoists.	Variable Speed Motors.
Back Geared Induction Motors.	Elevator Motors.
Vertical Induction Motors.	Crane Motors.
	Machine Tool Motors.
	Submarine Motors.
	Mill Type Motors
	Car Lighting Equipment.

BRANCH OFFICES

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ALLENTOWN, PA.....Hunsicker Bldg.
DETROIT, MICH.....Book Bldg.
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BOSTON, MASS.....88 Broad St.

Electro-Magnetic Tool Company

Main Office and Factory

2902 Carroll Avenue

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Apparatus Manufactured

HAMMERS—Portable Electric

For drilling concrete, stone and brick, channeling, chipping, trenching, wrecking, etc.
Equipped with D. C. or Universal Motors in five sizes.

DRILLS—Portable Electric

For drilling metals and wood.
Various sizes and voltages.
Equipped with Universal or D. C. Motors.

GRINDERS—Tool Post

For precision external and internal grinding.
Various sizes.

TIE TAMPERS

For tamping railroad ties.

Branches in Principal Cities.

The Emerson Electric Mfg. Co.

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APPARATUS MANUFACTURED

Direct Current Motors, 2 H. P. and smaller.
Single Phase Motors, split phase types, ½ H. P. and smaller.
Single Phase Motors, repulsion-start induction types, 2 H. P. and smaller.
Single Phase Motors, repulsion types, 2 H. P. and smaller.
Multiphase Motors, 2 H. P. and smaller.
Direct Current Generators, 1½ K. W. and smaller.
Alternating Current Oscillating and Non-Oscillating Fans.
Alternating Current Ceiling Fans.
Direct Current Oscillating and Non-Oscillating Fans.
Universal Oscillating and Non-Oscillating Fans.
Direct Connected Forge Blowers, A. C. and D. C.
Direct Connected Exhaust and Ventilating Fans, A. C. and D. C.
Universal Motor-Lathes.

BRANCH OFFICE

NEW YORK CITY . . . 50 Church Street

Fairbanks, Morse & Co.

CHICAGO, ILL.

APPARATUS MANUFACTURED

DIRECT CURRENT	ALTERNATING CURRENT
Engine Type Generators	*Engine Type Alternators*
Belted Type Generators	*Belted Type Alternators*
3-wire Belted Type Generators	*Synchronous Motors*
Interpole Motors for constant and variable speed	*Squirrel Cage Motors*
Elevator Motors	*Slip Ring Motors*
Hoist Motors	*Self-starter Motors*
Automatic Gasoline-Electric House-Lighting Sets	*Elevator Motors*
	Hoist Motors
	Motor-Generators

Machines equipped with either sleeve or ball bearings

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JACKSONVILLE, FLA.	DENVER, COLO.
NEW ORLEANS, LA.	SAN FRANCISCO, CAL.
NEW YORK, N. Y.	LOS ANGELES, CAL.
BOSTON, MASS.	SPOKANE, WASH.
BALTIMORE, MD.	SEATTLE, WASH.
LOUISVILLE, KY.	PORTLAND, OREGON
DETROIT, MICH.	SALT LAKE CITY, UTAH
CINCINNATI, OHIO	INDIANAPOLIS, IND.
LONDON	BUENOS AIRES

General Electric Company

SCHENECTADY, N. Y.

SOME OF THE APPARATUS MANUFACTURED

Turbines, Converters, Generators, Instruments, Locomotives, Line Material, Meters, Motors, Motor Starting and Control Devices, Switchboards, Circuit Breakers, Transformers, Wiring Supplies, Wires and Cables, Fans, Electric Lamps, etc.

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BUTTE, MONT.
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CHARLOTTE, N. C.
CHATTANOOGA, TENN.
CHICAGO, ILL.
CINCINNATI, OHIO
CLEVELAND, OHIO
COLUMBUS, OHIO
*DALLAS, TEXAS
DAYTON, OHIO
DENVER, COLO.
DES MOINES, IOWA
DETROIT, MICH.
DULUTH, MINN.
ELMIRA, N. Y.
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HARTFORD, CONN.
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KANSAS CITY, MO.
KNOXVILLE, TENN.
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LOS ANGELES, CAL.
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MEMPHIS, TENN.
MILWAUKEE, WIS.
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NASHVILLE, TENN.
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NEW YORK, N. Y.
NIAGARA FALLS, N. Y.
*OKLAHOMA CITY, OKLA.
OMAHA, NEB.
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*Southwest General Electric Company.

For Business Outside of the United States:
International General Electric Company, Inc.,
120 Broadway, New York. Schenectady, N. Y.

Goodman Manufacturing Co.

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APPARATUS MANUFACTURED

Electric Coal Cutting Machinery
Electric Locomotives

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CHARLESTON, W. VA. . .	Union Building
ST. LOUIS, MO.	Boatmen's Bank Bldg.
DENVER, COL.	Boston Bldg.
BIRMINGHAM, ALA. . . .	Brown-Marx Bldg.
SEATTLE, WASH.	576 First Avenue, So.

Gould Storage Battery Company

30 EAST 42ND STREET

NEW YORK CITY

Hamilton-Beach Mfg. Company

RACINE, WIS.

Sew E-Z Sewing Motors
New-Life Vibrators
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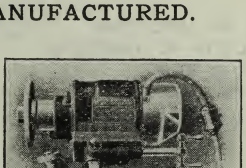
H-B Tool Post Grinders
H-B Jeweler's Lathe Motors
H-B Power Motors, Fractional Hp.

The Hisey Wolf Machine Company

Colerain and Marshall Aves.

CINCINNATI, OHIO.

APPARATUS MANUFACTURED.



Portable Electric Tool Post Grinders, ¼ and ½ H.P. size, with and without Slide Adjustment.

Portable Electric Drills for Direct Current, Alternating Current, also Universal motor machines for operation on Direct Current and Alternating Current.

Bench and Floor Grinders. Made in ½, 1, 2, 3, 5 and 10 H.P. sizes.

Also manufacturers of Portable Electric Bench and Floor Buffing Lathes, Surface Grinders, Angle Plate Grinders, Screw Driver, Scotch Radial Drills, Heavy Duty Drills and Reamers.

The Holtzer-Cabot Electric Co.

ROXBURY, BOSTON, MASS.

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APPARATUS MANUFACTURED

Fractional horse-power Direct Current Motors; Fractional horse-power single- and Poly-phase Alternating Current Motors; Direct Current Motors to 30 H. P.; Direct Current Generators to 20 K. W.; Poly-phase Alternating Current Motors, 1 to 30 H. P.; Direct Current Motors, adjustable speed, up to 2 H. P.; Motor Generators; Dynamotors; Reversed Rotaries; Plating Dynamos; Buffing and Grinding Motors; Dental and Jewelers' Lathe Motors; Gas Engine Generating Units; Multicycle Motor Generator Sets; Gas Engine Magnetos; Alternating Current Magnetos; Magneto Tachometers; Wireless Motor Generators; Farm Lighting Outfits.

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NEW YORK.....101 Park Avenue
DETROIT.....951-952 Book Bldg.
ST. LOUIS.....The Arcade Bldg.
MINNEAPOLIS.....Metropolitan Life Bldg.

Howell Electric Motors Company

HOWELL, MICHIGAN

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APPARATUS MANUFACTURED

POLYPHASE MOTORS EXCLUSIVELY

1 to 100 H. P.—All Types.

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PHILADELPHIA
DETROIT
CLEVELAND
ST. LOUIS
BUFFALO
MINNEAPOLIS
DALLAS
GRAND RAPIDS
SAGINAW
SEATTLE
MILWAUKEE
SAN FRANCISCO
LOS ANGELES

The IDEAL ELECTRIC
& Manufacturing Co., Mansfield, Ohio

APPARATUS MANUFACTURED

ALTERNATING CURRENT

Belted Alternators
Squirrel Cage Motors
Slip Ring Motors
Elevator Motors
Hoist Motors
Pump Motors
Motor Generators

DIRECT CURRENT

Engine Type Generators
Belted Generators
3 Wire Belted Generators
3 Wire Balancer Sets
Constant & Variable Speed
Interpole Motors
Elevator Motors
Hoist Motors
Pump Motors

BRANCH OFFICES

NEW YORK
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PITTSBURGH
CHARLOTTE
BIRMINGHAM
NEW ORLEANS
CLEVELAND
GRAND RAPIDS
CHICAGO
MILWAUKEE
MINNEAPOLIS
KANSAS CITY
SAN FRANCISCO
SEATTLE

The Imperial Electric Company

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Direct Current Motors, both constant and variable speed, from ½ H.P. to 50 H.P. Also Direct Current Dynamos for all voltages and Polyphase Alternating Current Motors in sizes from 1 H.P. to 75 H.P. Designed for all classes of work.

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MINNEAPOLIS	Metropolitan Life Bldg.
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Electric Arc Welders for all purposes.

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Direct Current Machinery Only for All Standard Voltages.

Standard Motors
Vertical Motors
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Special Motors of All Kinds

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Direct Connected Generators
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Moloney Electric Company

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Special Transformers for any capacity, frequency or voltage

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PORTABLE FLEXIBLE SHAFT SCREW DRIVERS.
PORTABLE DIRECT CONNECTED CIRCULAR SAWS.

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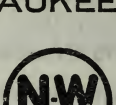

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ALTERNATING CURRENT MOTORS
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Type "AS" Armature Shifting Design

Runs at any speed and develops a constant horsepower output over any range up to 1 to 10. Smooth and gradual changes in speed are obtained by shifting the motor armature.

Type "T" Inter-pole field resistance control.

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Type "T" shunt or compound wound

Type "T" Inter-pole, shunt or compound pound wound

Direct Current Generators

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Wound rotor with slip rings

High Resistance Squirrel Cage Rotor

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DENVER	Boston Building
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ATLANTA	Healey Building
NEW ORLEANS	408 Canal Street

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Direct Current Motors
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Direct Current Generators
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Special Electrical Apparatus

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Constant and adjustable speeds.
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Direct current dynamos.

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Direct Current Motors, 1-4 *to* 50 *H.-P.*
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Elevator Motors
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Electric Grinding Motors
Direct Current Generators, 1-8 *to* 65 *K.W.*
Alternating Current Generators, 2 *to* 100 *K.V.A.*
Special Electrical Machinery

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High Speed Turbo Generators.
Engine Type Generators.
Belted Type Generators.
Standard Commutating Pole Motors.
Special Eight-Pole Motors.
Special Fractional Horse Power Motors.
Electric Heat Blowers.

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Small Turbo Generators (Single and Three Phase)
Standard Single Phase and Polyphase Induction Motors.
Special Fractional Horse Power Motors.
Electric Heat Blowers.

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The Temco Electric Motor Co.

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TEMCO
Trade Mark

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Portable Electric Drills.
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Direct and Alternating Current Generators, belted type.

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Elevator Motors, both direct and alternating current.

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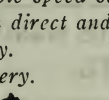

"True in the Long Run"

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Union Electric Mfg. Co.

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Cranes, Hoists, Derricks, Pumps, Blowers, Mine Locomotives, Industrial Trucks, Machine Tools, Line Shafts and All Industrial Motor Applications.
1 to 150 H.P.

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Chicago, Ill.
St. Louis, Mo.
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The United States Electrical Tool Co.

CINCINNATI, OHIO.

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Portable Electric

Hand Drills
Bench Drills
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Center Grinders
Bench Grinders
Bench Buffers
Hand Grinders
Hand Buffers
Floor Grinders
Floor Buffers

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DETROIT
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U. S. Electrical Mfg. Co.

MAIN OFFICE AND FACTORY
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Polyphase, constant and variable speed, alternating current motors in standard voltages, all speeds and types, ¼ to 30 H. P.

Ball bearing electric grinding and buffing motors.

Special single phase motors and direct current apparatus.

Special elevator motors

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Plating dynamos

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APPARATUS MANUFACTURED

Single-phase Motors; Polyphase Motors; Distribution and Power Transformers; Portable and Switchboard Instrument Transformers; Rectifiers; Converters for changing alternating current to direct for Motion Picture Projection and Battery Charging; Automobile Engine Starters; Battery Ignition; Electric Automobile Motors.

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BOSTON	88 Brookline Avenue
BUFFALO, N. Y.	311 Niagara Life Bldg.
CHICAGO	918 So. Michigan Ave.
CINCINNATI	1607 First Nat'l Bank Bldg.
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DALLAS, TEXAS	1111 Jackson Street
DENVER	1633 Tremont Street
DETROIT	1291 Woodward Avenue
HAVANA, CUBA	40 Muralla
INDIANAPOLIS, IND.	922 N. Pennsylvania Ave.
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MELBOURNE, AUSTRALIA	127-137 Elizabeth St.
MEMPHIS, TENN.	681 Mosby St.
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NEW YORK CITY	30 Church Street
OMAHA, NEB.	3102 Sherman Ave.
PHILADELPHIA	1632 Sansom St.
PITTSBURGH	947 Penn Avenue
ST. PAUL, MINN.	1114 Pioneer Bldg.
ST. LOUIS, MO.	3029 Locust St.
SALT LAKE CITY, UTAH	Walker Bank Bldg.
SAN FRANCISCO	159 New Montgomery Street
SEATTLE, WASH.	538 First Ave., South.
TORONTO, ONT.	183 George St.
WASHINGTON, D. C.	406 Wilkins Bldg.

Ward Leonard Electric Company

Mount Vernon, New York

OFFICERS

LEONARD KEBLER ..... President
D. J. BURNS ..... Vice-President
WALTER H. MOTT ..... Secretary and Treasurer

Generator Rheostats
Motor Rheostats
Resistance Units
Circuit Breakers
Theatre Dimmers
Circuit Controlling Devices
Automatic Dynamo Controllers for Electric Lighting and Starting Systems

AGENTS IN PRINCIPAL CITIES

Westinghouse Elec. & Manuf'g Co.

EAST PITTSBURGH, PA.

APPARATUS MANUFACTURED

Generators, Motors, Rotary Converters, Switchboards, Switchboard Instruments, Watthour Meters, Graphic Recording Meters, and other auxiliary electrical apparatus for the generation, control, transmission and application of electric power.

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MINNEAPOLIS, MINN.
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